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FINAL REPORT ON MANUFACTURING METHODS FOR METALLIZED TEFLON CAPACITORS (Subminiature 200°C)

TECHNICAL DOCUMENTARY REPORT NR. ASD-TDR-63-308
April 1963

Electronic Branch
Manufacturing Technology Laboratory
Aeronautical Systems Division
Air Force Systems Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

ASD Project Nr. 7-604

(Prepared under Contract AF 33(600) 38431 by the Dearborn Electronic Laboratories, Inc., Orlando, Florida, Douglas H. Smith.)

ABSTRACT
Technical Documentary Report

ASD-TDR-63-308
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FINAL REPORT ON MANUFACTURING METHODS FOR METALLIZED TEFLON CAPACITORS
(Subminiature 200°C)

Douglas H. Smith
et al
DEARBORN ELECTRONIC LABORATORIES, INC.

Metal encased tubular, hermetically sealed, metallized teflon capacitors which reduce the volume per microfarad of capacitance up to one-fourth that of conventional teflon dielectric foil capacitors can now be fabricated on a production basis. These subminiature metallized teflon capacitors are designed to opeate over a temperature range of -65°C to 200°C and are capable of withstanding the severe environmental conditions encountered by missiles and space vehicles.

Available winding machines were modified for the winding of thin teflon film because of the films tendency to distort in both width and thickness when not held under constant or controlled tension. These modifications were all directed toward the exertion of constant tension on the winding material thereby alleviating major winding problems.

The composite type construction employing one aluminum metallized teflon electrode and one standard aluminum foil electrode was used in the construction of the capacitors. Lead attachments were made by spraying the ends of the capacitor with a high temperature aluminum solder.

The capacitors fabricated using multiple layers of material were satisfactory upon completion of load life testing for a period of 1000 hours with a 140% of rated voltage at a temperature of 200°C. However, the capacitors fabricated with single layer material failed the 1000 hour load life test because numerous momentary breakdowns weakened or destroyed the connections between the sprayed end connections and the electrodes.

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PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

Arden B Hughes

ARDEN B. HUGHES
Lt Colonel, USAF
Chief, Manufacturing Technology Laboratory
Director of Materials & Processes

FOREWORD

This Final Engineering Report covers all work performed under Contract AF 33(600)-38431 from March 1959 to April 1963. The manuscript was released by the author on 1 April 1963 for publication as an ASD Technical Report.

This contract with the Dearborn Electronic Laboratories, Inc., Orlando, Florida, was initiated under Manufacturing Methods Project 7-604, "Metallized Teflon Capacitor". It was accomplished under the technical direction of Mr. H. K. Trinkle, Project Engineer, of the Electronics Branch, Manufacturing Technology Laboratory, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

Mr. Douglas H. Smith of the Research Deparment of Dearborn Electronic Laboratories, Incorporated was the engineer in charge of this project. Others who cooperated in the research and in the preparation of this report were: Mr. R. J. Simpson, Director of Research and Mr. E. D. A. Geoghegan, Vice President in Charge of Engineering.

This project has been carried out as part of the Air Force Manufacturing Methods Program. The primary objective of the Air Force Manufacturing Methods Program is to develop on a timely basis manufacturing processes, techniques, and equipment for use in economical production of USAF materials and components. The program encompasses the following technical areas:

Rolled Sheets, Forgings, Extrusions, Castings, Fiber and Power Metallurgy Component Fabrication, Joining, Forming Materials Removal
Fuels, Lubricants, Ceramics, Graphites, Non-metallic Structural Materials Solid State Devices, Passive Devices, Thermionic Devices.

Your comments are solicited on the potential utilization of the information contained herein as applied to your present or future production programs. Suggestions concerning additional Manufacturing Methods development required on this or other subjects will be appreciated.

NOTICES

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I INTRODUCTION

The use of teflon capacitors in high temperature circuitry has expanded rapidly. However, the faults normally associated with thin teflon film has forced the use of multiple layers of dielectric between the foil electrodes to reduce the probability of the faults in the dielectric overlapping. The self healing characteristics of a metallized film permits the use of dielectric thicknesses one-half that of conventional teflon foil capacitors.

Successful self healing is achieved when a fault is cleared (the vaporization of the electrode surrounding the fault by the application of gradually increasing voltage), with negligible mechanical damage to the supporting dielectric and no discernible decrease in insulation resistance of the capacitor. These capacitors retain the desirable characteristics of conventional foil-teflon capacitors while offering greatly reduced size and self-healing characteristics.

The availability of metallized teflon capacitors which would afford a volumetric reduction of approximately four to one would be very advantageous. The development of these metallized teflon capacitors had been accomplished on a small scale; however, the techniques of producing them in large quantities had never been accomplished prior to this reported effort.

II MATERIALS

The thin teflon dielectric material, particularly .00025", contains numerous pin holes and conducting particles. One of the earlier considerations in the resolution of this problem was the casting of the film on an aluminum foil substrate and the use of the intergral electrode-dielectric, thereby eliminating pin holes normally caused by the separation of the substrate and the film.

One method was to coat the aluminum foil substrate on both sides with .00025" teflon, chemically etch the substrate 1/16" from one edge, mask 1/16" along the opposite edge of the integral electrode-dielectric to form the margin and metallize the masked side with aluminum, making possible the winding of a 100 volt unit from a single tape. An acid appeared to be the most feasible etching medium but the required uniform margin and complete neutralization of the acid could not be consistently obtained.

A second method consisted of a composite type construction which employed one aluminum metallized teflon electrode and one aluminum foil electrode. The metallized electrode being extremely thin affords the means whereby electrical faults may be cleared in the completed capacitor. By the use of the aluminum foil, the cost of the very expensive metallized teflon is reduced to half that of an all metallized teflon capacitor. The aluminum foil also gives the rigidity necessary to withstand temperature cycling and vibration.

At the inception of this contract, there was only one supplier for metallized teflon. This supplier produced metallized teflon with burned off margins. The spattered conducting particles remaining in the margins and the swelling at the margins caused by the heat generated in burning off the electrode made the finished product unsatisfactory for use both mechanically and electrically. The manufacturer of the teflon film selected for this project, Dilectrix Corporation, Farmingdale, Long Island, New York, was contacted to ascertain if it were possible to metallize teflon with masked margins. They were successful and

are presently the sole source for the metallized teflon used for this project.

The teflon tape used to insulate the cylindrical capacitor winding section surface was purchased from the Minnesota Mining and Manufacturing Company in widths equal to and slightly greater than the section widths.

The wire leads necessary for attachment to the section employ a flat spiral or "pigtail" design on one end which lies in a plane perpendicular to the axis of the lead.

Material used to spray the ends of the sections was produced by Alcoa and is their number 805 solder. The composition of this solder is approximately 60% zinc and 40% cadmium.

Electro-tinned brass tubes and glass to metal seals were used for the assembly and packaging of the sections and attached leads. Also used in the assembly and packaging operation was a silicone fluid resin, "Dow Corning XF1-0042".

III WINDING OPERATION

The capacitor section is accomplished by winding the element materials on a small diameter mandrel to form a roll. During the winding, proper alignment and tension is maintained to insure obtaining a capacitor section having good physical and electrical attributes.

Teflon has a tendency to stretch more under tension than other plastic films. When the film is stretched linearly, it causes a proportionate decrease in the width of the material. Because of the uneven tension applied on each roll, one width may decrease more than the other widths causing a varying dielectric thickness between the electrodes.

The Kroessler Manufacturing Company Model 485 semi-automatic winding machines used for this contract, employed a compression spring to apply variable pressure against a fixed friction surface and the end area of the spindle. The opposite end of the spindle being pushed by the spring resulted in a proportionate increase or decrease of friction between the spindle and the fixed surface thereby regulating the amount of pull necessary to unwind the material from the spindle. This method allowed too many variables in maintaining the desired torque. The amount of compressive force of the spring was governed by the manual positioning of a nut against the spring on a threaded extension of the spindle shaft. This manual setting depended on the individual operator's judgement and ability to arrive at a satisfactory torque. There was an added variable when a used roll was replaced with a new one and an attempt made to duplicate the previous torque.

To arrive at a more exact control, the winding machine was modified by eliminating the compression spring and substituting a permanent magnet in a recessed area in the body of the spindle to exert a controlled pull on the rotating iron disc which in turn converts this pull into a direct push of the spindle end plate against a stationary friction surface. An increase or decrease of the flux gap between the magnet and the disc results in a decrease or increase in friction. These modifications can be seen in Figures 1 through 8.

Further modification of the machine was made to remove the element of uncontrolled friction induced when material is run over a fixed length of radially curved metal guides. This modification was essential due to static conditions caused by friction produced by the plastic dielectric being drawn over a fixed metal guide and the varying degree of friction between the fixed and moving areas. The latter modification was essentially the substitution of flanged wheel guides for fixed guides. The wheels revolve directly with the moving material. These modifications can be seen in Figures 18 through 26.

Following the winding of a section, the materials are cut and the section wrapped with teflon tape. After this operation, the section is removed from the mandrel.

IV LEAD ATTACHMENT

The capacitor sections are next assembled in holding frames with the mandrel holes masked to prevent entrance of metal particles during the subsequent operation. The section ends are now sprayed with a metallizing gun to form built up surfaces for the attachment of wire lead terminations.

The first group of capacitors fabricated had the ends of the wound sections metallized with pure tin to form a base for lead attachment. The leads were then fused to the base using a resistance soldering device. It was found that the tin became oxidized and embrittled after exposure to 200°C for a period of 1000 hours. The capacitors exhibited high dissipation factor and/or were open circuited at the elevated temperature. Subsequent 25°C electrical measurements indicated however, these capacitors satisfied the specification requirements in all respects.

Additional groups of capacitors were fabricated utilizing end-sprays of (1) pure copper spray, (2) 97 1/2% lead/ 2 1/2% silver and (3) high temperature aluminum spray.

The capacitors end-sprayed with pure copper were subjected to the high ambient test temperature of 200°C. Within seven days, the bonding material had become badly oxidized and the thermal expansion of the teflon plus the corroded condition of the copper caused the metal to partially separate from the ends of the capacitor sections.

Capacitors end-sprayed with a combination of 97 1/2% lead/ 2 1/2% silver were subjected to the 200°C environment. Within seven days, extensive corrosion of the metal had occurred making the bond mechanically unacceptable.

The third group of capacitors fabricated were end-sprayed with high purity aluminum. Bonding remained unimpaired at 200°C but the excessively high temperature required to melt the pure aluminum made attachment of wire terminations difficult

and adversely affected the electrical characteristics of the capacitors. Due to this latter condition, no further consideration was given to this material.

Further research and investigation of materials which might be satisfactory and possess a lower melting point than pure aluminum revealed the existence of an aluminum solder known as Alumaweld H9.

An additional group of capacitors end-sprayed with the aluminum solder (Alumaweld H9) were subjected to the 200°C environment. After a period of 1000 hours, the material showed no visible evidence of oxidization. Bond adherence and resistance to the thermal expansion effects of the teflon remained unimpaired. The Alumaweld H9 material is available only in short lengths of square rod and had to be hand fabricated into round wire by drawing it through a jewelers' draw so that a metallizing gun could be employed for the end-spraying.

In an attempt to eliminate the difficulties encountered in spraying with the short lengths of Alumaweld H9, Alcoa 805, round wire aluminum solder which is equivalent to the Alumaweld H9 in composition, was obtained. This material was used to end-spray all capacitors manufactured under this contract.

Following the spraying operation, the mandrel hole masking tape strips are removed and a dry towel is used to wipe away excess spray deposits from the teflon tape.

Attachment of the "pigtail" leads is accomplished through the use of a resistance soldering device shown in Figure 18 . The section end is held against the flat spiral end of the lead whose opposite edges contact the carbon posts. When the circuit is completed, a current flows across the spiral heating and soldering the lead in place.

V ELECTRICAL TESTS

After lead attachment, the sections are tested for dielectric strength by the application of 200% of rated voltage for a period of one minute with the current limited to less than one ampere.

Some difficulty was experienced in the dielectric strength tests of the 4 µf 100 volt units. It was found that the application of the 200 volt test potential burned the metallization from the ends of the sections causing opens and/or high dissipation factor. This problem was resolved by initially clearing the units at a potential of 50 volts and then increasing the voltage slowly to the full 200 volt test potential. (Clearing is the vaporization of the electrode surrounding the fault by the application of gradually increasing voltages.)

The sections are then tested for capacitance and dissipation factor using a standard capacitance bridge. The insulation resistance is then measured at a test potential of 100 VDC. The total electrification time is two minutes for this test.

VI ASSEMBLY

After passing the above electrical tests, a section is next assembled or packaged. The initial step of this operation is to wrap the units with a few turns of teflon tape that is slightly wider than the section length. This excess tape is then crimped around the leads at the section ends and the section is placed in an electro-tinned brass tube which has previously had one glass to metal end seal soldered in place. The soldering of the second end seal is accomplished in a similar manner by means of induction soldering. The lead-thru insert or eyelet of this end seal is left open for further processing.

Teflon is known to be particularly susceptible to ionic bombardment which causes a rapid deterioration of the material. It thus becomes essential in high voltage applications where the possibility of corona exists, to insure the absence of easily ionizable components such as air or vapor. In order to eliminate this situation, the units were filled with a suitable resin which will:

1. Not substantially reduce the insulation resistance at 200°C.
2. Provide mechanical support capable of withstanding:
   (a) vibration, high frequency, 55-2000 cps @ 15 g.
   (b) shock, 50 g in 11 $\pm$ 1 ms.
   (c) acceleration (constant) 30 g in 10 seconds.
3. Replace the low dielectric strength air with a material of a higher dielectric strength.

It was found that the material that best satisfies the above requirements is "Dow Corning XF 1-0042 silicone fluid".

The units to be impregnated were placed in a vacuum chamber and held at 125°C at reduced pressure to remove all air and moisture. The fluid was placed in a separate chamber and was evacuated at room temperature to remove air which had become entrapped because of the admixture of the catalyst. The chamber containing the fluid had a tube leading from the bottom

of the container to the top of the chamber containing the capacitors.

The temperature on the chamber containing the capacitors was reduced to 25°C. The vacuum on the chamber containing the fluid was released and the fluid was transferred to the chamber containing the units. The chamber containing the capacitors remained under vacuum for one hour. The fluid was of sufficient quantity to cover, at all times, the capacitors being filled.

Directly after filling, the units were placed in the oven at 160°C for 18 hours to allow the fluid to gel. The capacitors were then removed from the oven and allowed one hour to come to room temperature before the final eyelet was sealed.

Before going to the final series of environmental tests, the units are cleaned in a trichlorethylene solution to remove grease, film, etc, and are marked with appropriate labels.

VII ENVIRONMENTAL TESTS

Following completion and cleaning of the finished capacitors, a series of tests were run to insure that the capacitors met the required specifications. The dielectric strength, capacitance, dissipation factor and insulation resistance tests were performed again on a 100% basis.

Next, the capacitors were life tested for a period of 1000 hours at 140% of rated voltage at 200°C. The capacitors were separated by a distance of not less than one (1) inch. Adequate circulation of air was provided to prevent the temperature within six (6) inches of any capacitor from departing more than ± 3°C from the nominal ambient temperature of the chamber. The voltage was applied individually to each capacitor through a resistance of at least one ohm per volt.

A failure was defined as any one of the following:

1. A permanent short or open circuit.
2. A decrease in capacitance to less than 90% of the capacitance before test.
3. A decrease in insulation resistance to less than 30% of the value specified.

.001 µf 100 VDC

Exhibits 1 and 2 show in tabular form the preliminary measurements as well as the successful results of the 1000 hour load life test conducted on twenty four (24) specimens at 140% of rated voltage.

.01 µf 1000 VDC

Exhibits 3 and 4 show in tabular form the preliminary measurements as well as the successful results of the 1000 hour load life test conducted on twenty four (24) specimens at 140% of rated voltage at 200°C.

.047 µf 1000 VDC

Exhibits 5 and 6 show in tabular form the preliminary measurements as well as the successful results of the 1000 hour load life test conducted on twenty four (24) specimens at 140% of rated voltage at 200°C.

.1 µf 600 VDC

Exhibits 7 and 8 show in tabular form the preliminary measurements as well as the successful results of the 1000 hour load life test conducted on twenty four (24) specimens at 140% of rated voltage at 200°C.

.47 µf 600 VDC

Exhibits 9 and 10 show in tabular form the preliminary measurements as well as the successful results of the 1000 hour load life test conducted on twenty four (24) specimens at 140% of rated voltage at 200°C.

1.0 µf 400 VDC

Exhibits 11 and 12 show in tabular form the preliminary measurements as well as the successful results of the 1000 hour load life test conducted on twenty four (24) specimens at 140% of rated voltage at 200°C.

2.0 µf 200 VDC

Exhibits 13 and 14 show in tabular form the preliminary measurements as well as the results of the 1000 hour load life test conducted on twelve (12) specimens at 140% of rated voltage at 200°C. The test data indicated that two (2) of the units exceeded the dissipation factor requirement of .5% and three (3) additional units were open after life test. High energy produced by numerous momentary breakdowns weakened and/or destroyed the connection between the sprayed end terminations and the electrodes.

4.0 μf 100 VDC

Exhibits 15 and 16 show in tabular form the preliminary measurements as well as the results of the 1000 hour load life test conducted on twelve (12) specimens at 140% of the rated voltage at 200°C. The test data indicates that three (3) of the units exceeded the dissipation factor requirement of .5% and three (3) additional units were open after life test. High energy produced by numerous momentary breakdowns weakened and/or destroyed the connection between the sprayed end terminations and the electrodes.

The 2.0 μf and 4.0 μf units did not prove feasible for production under this metallized film winding process because of their failure to readily "clear" of shorts, thus greatly reducing their yield and reliability levels. This may be attributed to the fact that the total energy storage for these larger capacitances could not be controlled in the "clearing" operation.

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PROPOSED MILITARY SPECIFICATION
FOR
CAPACITORS, FIXED METALLIZED FILM DIELECTRIC, DIRECT CURRENT
HERMETICALLY SEALED METALLIC CASES

1. SCOPE

1.1 SCOPE.- This specification covers metallized teflon dielectric fixed capacitors, hermetically sealed in metallic cases intended for use in power supply filter circuits, by-pass and other applications where the alternate current (a.c.) components of voltage is small with respect to the direct current (d.c.) rating and where occasional momentary[1] breakdowns can be tolerated. These capacitors shall be capable of continuous operation over the temperature range of -65°C to +200°C and withstanding the severe environmental conditions encountered in high speed aircraft and/or missiles.

1.2 CLASSIFICATION

1.2.1 Type designation for capacitors.- The type designation for capacitors shall be in the following form, and as specified.

CX08	A	1	T	A	105	J
Style (1.2.1.1)	Terminal (1.2.1.2)	Circuit (1.2.1.3)	Temperature (1.2.1.4)	Voltage (1.2.1.6)	Capacitance (1.2.1.5)	Capacitance tolerance (1.2.1.7)

1.2.1.1 Style.- The style is identified by the two letter symbol CX, followed by a two digit number; the letters CX identify plastic dielectric capacitors. The number identifies the dimensional requirements of the capacitor as specified in the detail specification.

[1]Momentary breakdown is defined as a single or a series of rapidly succeeding capacitor discharges evidenced by abrupt decreases in insulation resistance of values below the limit specified in and followed by restoration of the resistance to a value above this limit.

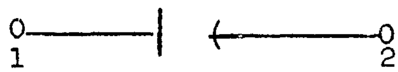
1.2.1.2 **Terminal.-** The terminal is identified by a single letter in accordance with Table I.

TABLE I.- TERMINAL

Symbol	Type of Terminal
A	Axial-wire lead
B	Solder lug (Non-removable)
C	Threaded Stud and nuts
D	Pillar insulator for use at altitudes up to 7,500 feet. Furnished with threaded stud and nuts; also includes solder lug for capacitors rated at 3000 volts d.c. and less.
E	Pillar insulator for use at altitudes up to 50,000 feet.

1.2.1.3 Circuit.- The circuit diagram and number of terminals are identified by a single digit in accordance with Table II.

TABLE II.- CIRCUIT DIAGRAM AND NUMBER OF TERMINALS

Symbol	Circuit diagram	Number of terminals
1		2

1.2.1.4 Temperature Range.- The temperature range is identified by a single letter in accordance with Table III.

TABLE III.- TEMPERATURE RANGE

Letter Designation	Working Temperature Range
T	-55°C to 200°C

1.2.1.5 The nominal capacitance value expressed in micro-micro-farads is identified by a three-digit number; the first two digits represent significant figures and the last digit specifies the number of Zero to follow.

1.2.1.6 Voltage.- The dc working voltage is identified by a single letter in accordance with table IV.

TABLE IV.- VOLTAGE RATING

Symbol	DC Voltage Rate	Symbol	DC Voltage Rating
B	100	K	2,500
C	200	L	3,000
D	300	M	4,000
E	400	N	5,000
F	600	P	6,000
G	1,000	R	7,500
H	1,500	S	10,000
J	2,000	T	12,500

1.2.1.7 Capacitance Tolerance.- The capacitance tolerance in percent is identified by a single letter in accordance with table V.

TABLE V.- CAPACITANCE TOLERANCE

Symbol	Tolerance in percent
G	$\pm$ 2
J	$\pm$ 5
K	$\pm$ 10

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on the date of invitation for bid shall form a part of this specification to the extent specified herein.

MILITARY SPECIFICATIONS

MIL-C-25C Capacitors, Fixed, Paper-Dielectric, Direct-Current (Hermetically Sealed in Metallic Cases)

WADC TECHNICAL REPORTS

WADC TR 57-265 Metallized Teflon Capacitors
(ASTIA Document No. AD 131021

3. REQUIREMENTS

3.1 Qualifications.- Capacitors furnished under this specification shall be a product which has been tested and has passed qualification testing specified in 4.4.

3.2 Materials.- When a definite material is not specified, a material shall be used which will enable the capacitors to meet the performance requirements of this specification. Acceptance or approval of constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.2.1 Insulating, impregnating and filling compounds.- Compounds used in the impregnation and filling of capacitors shall be chemically inactive with respect to the capacitor unit and the case. The compound, either in the state of original application or a result of having aged, shall have no adverse effect on the performance of the capacitors.

3.2.2 Metals. - Metals shall be used which will meet the performance requirements of the specification. (See 3.10.)

3.3 Design and Construction.- The capacitors shall be of the design, construction and physical dimensions specified.

3.3.1 Case.- Each capacitor shall be enclosed in a hermetically sealed metallic case which will protect the capacitor element from moisture, and mechanical damage under all the specified test conditions.

3.3.2 Capacitor elements.- The capacitor elements shall consist of conducting layers separated by one or more layers of tetrafluorethylene.

3.3.2.1 Non inductive construction.- Capacitors shall be of extended foil or equivalent construction.

3.7 Dissipation factor.- The dissipation factor shall not exceed .5 percent (see 4.6.5.).

3.8 Flashover.- When the capacitors are tested as specified in 4.6.6, there shall be no momentary or intermittent arcing or other indication of breakdown nor shall there be any visible evidence of damage.

3.9 Vibration.- As a result of the test specified in 6.7, there shall be no mechanical damage and the measurement shall show no evidence of intermittent contacts or open or short-circuiting.

3.10 Corrosion.- As a result of the tests specified in 4.6.8, 4.6.9 and 4.6.10, there shall be no harmful or extensive corrosion and at least 90 percent of any exposed metallic surfaces of the capacitor or bracket shall be protected by the finish. The marking shall remain legible. In addition, there shall be not more than 10 percent corrosion of the terminal hardware or mounting surface.

3.11 Temperature and immersion cycling.- When tested as specified in 4.6.9, capacitors shall meet the following requirements:

Dielectric strength:

Terminal to terminal.	As specified in 4.6.2.1.
Terminal to case (when case is not a terminal).	As specified in 4.6.2.1.

Insulation resistance:

Terminal to terminal.	Not less than 30 percent of the value specified in 3.5.1.
Terminal to case (when case is not a terminal).	Not less than 50 percent of the value specified in 3.5.2.

3.12 Moisture resistance.- When tested as specified in 4.6.10, capacitors shall meet the following requirements:

Dielectric strength:

Terminal to terminal. . . .	As specified in 4.6.2.1.
Terminal to case (when case is not a terminal).	As specified in 4.6.2.1

Insulation resistance:

Terminal to terminal. . . .	Not less than 30 percent of the value specified in 3.5.1.
Terminal to case (when case is not a terminal).. . . .	Not less than 50 percent of the value specified in 3.5.2.

3.13 Low temperature.- When tested as specified in 4.6.12, capacitors shall withstand the application of rated d.c. voltage without flash-over or breakdown.

3.14 Life.- When tested as specified in 4.6.13, capacitors shall meet the following requirements:

Breakdown.	The total number of breakdowns indicated by the register circuit shall not exceed 8 per microfarad of the total capacitance of the group tested or 2, whichever is greater.
Insulation resistance. . .	Megohms or megohms times microfarads as applicable. Not less than 30 percent of the value specified in 3.5.1 and table VI.
Capacitance.	Change not more than 10 percent from initial value when measured as specified in 4.6.4.

There shall be no mechanical failure or open or short-circuiting.

3.15 Seal.- When capacitors are tested as specified in 4.6.11, there shall be no evidence of repetitive bubbling.

3.16 Marking.- Capacitors shall be marked in accordance with Mil-Std-130 with the manufacturers name or code symbol, type designation, capacitance and voltage rating. Marking shall remain legible after all testing.

3.17 Workmanship.- Capacitors shall be processed in such a manner as to be uniform in quality and shall be free from pits, corrosion, cracks, rough edges and other defects that will affect life, serviceability, or appearance.

3.17.1 Soldering

3.17.1.1 Flux.- Flux for soldering of electrical connections shall be rosin, rosin and alcohol, or rosin and turpentine. No acid or acid salts shall be used in preparation for or during soldering; however, exception is permitted for preliminary tinning of electrical connections and for tinning or soldering of mechanical joints not used to complete electrical circuit, but in no case shall acid or acid salts be used where they can come in contact with insulation material. Where acid or acid salts are used as permitted above, they shall be completely neutralized and removed immediately after use. All excess flux and solder shall be removed. Where possible, electrical connections shall be mechanically secure before soldering and electrically continuous after soldering.

3.17.1.2 Process.- There shall be no sharp points or rough surfaces resulting from insufficient heating. The minimum necessary amount of flux and solder shall be used for electrical connections. Any means employed to remove an unavoidable excess of flux shall not incur the risk of loose particles of flux, brush bristles, or other foreign material remaining in or on the capacitor; flux being spread over a large area; or damage to the capacitor. Insulation material that has been subjected to heating during the soldering operation shall be undamaged and parts fastened thereto shall not have loosened.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.

4.1.1 Supplier.- The supplier is responsible for the performance of all inspection requirements as specified herein. Except

as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1.1 Test equipment and inspection facilities.- Test equipment and inspection facilities shall be of sufficient accuracy, quality and quantity to permit performance of the required inspection. The supplier shall establish calibration of inspection equipment to the satisfaction of the Government.

4.1.1.2 Additional inspection.- Nothing specified herein shall preclude the supplier from taking such additional samples and making such additional inspection as he may deem necessary or desirable to assure conformance of the capacitors to this specification.

4.1.2 Government.- Acceptance of the capacitors shall be based upon verification by the Government of the supplier's compliance with the requirements of this specification. The Government may, at its option, repeat any or all of the inspections specified here. (See 6.2.)

4.2 Classification of inspection.- The examination and testing of capacitors shall be classified as follows:

(a) Qualification inspection. (See 4.4.)
(b) Acceptance inspection. (See 4.5.)
  1. Inspection of product for delivery.(See 4.5.1.)
  2. Inspection of preparation for delivery.(See 4.5.2.)

4.3 Inspection conditions.- Unless otherwise specified herein, all inspection shall be made at room ambient temperature, relative humidity and pressure.

4.4 Qualification inspection.- Qualification inspection will be performed at a laboratory designated by the Government. (See 6.2.)

4.4.1 Test routine.- Sample units will be subjected to the qualification inspection specified in table VII, in the order shown. Two sample units in a sample will be subjected to visual and mechanical examination (internal). The remaining sample units will then be divided into three groups as specified in table VII and subjected to the inspection for their particular group; for combined-type submissions, each type will be equally represented in each group.

TABLE QUALIFICATION TEST FOR CAPACITORS

Test	Requirement Paragraph	Test Paragraph	Number of specimens to be tested	Number of defectives allowed[1]
Test Group I				
Visual and mechanical inspection: Material, design, construction, and physical dimensions	3.2 to 3.3.2.1 inc. &	4.6.1	2	1
Workmanship (internal)	3.17 to 3.17.2 inc.			
Marking[2]	3.16			
Workmanship (external)	3.17 to 3.17.2 inc.			
Seal	3.15	4.6.11		
Dielectric strength	3.4	4.6.2		
Insulation resistance	3.5	4.6.3	24	1
Capacitance	3.6	4.6.4		
Dissipation factor	3.7	4.6.5		
Flash-over	3.8	4.6.6		
Test Group II				
Vibration	3.9	4.6.7		
Corrosion	3.10	4.6.8	6	1
Temperature and immersion cycling	3.11	4.6.9		
Test Group III				
Moisture resistance	3.12	4.6.10	6	1
Test Group IV				
Low temperature	3.13	4.6.12	12	1
Life	3.14	4.6.13		

1

[1]A specimen having one or more defects will be considered as one defective.

[2]Marking defects are based on visual examination only and will be charged only for illegible, incomplete, or incorrect marking. Subsequent electrical defects will not be used for determining defects

4.4.2 Defectives.- Defectives in excess of those allowed in table VII will be cause for refusal to grant qualification.

4.5 Acceptance inspection.

4.5.1 Inspection of product for delivery.- Inspection of product for delivery shall consist of production inspection, and groups A, B and C.

4.5.1.1 Production inspection.- Production inspection shall consist of the tests specified in table VIII, in the order shown, and shall be performed on each capacitor.

TABLE VIII. Production inspection

Test	Requirement paragraph	Method paragraph
Seal	3.15	4.6.11
Dielectric withstanding voltage	3.4	4.6.2
Capacitance	3.6	4.6.4

4.5.1.2 Inspection lot.- An inspection lot, as far as practicable, shall consist of capacitors having the same voltage rating and number of dielectric layers, produced under essentially the same conditions and offered for inspection at the same time. Each lot shall be kept separate from every other lot.

4.5.1.3 Group A inspection.- Group A inspection shall consist of the examinations and tests specified in table IX, in the order shown.

4.5.1.3.1 Sampling plan.- Statistical sampling and inspection shall be in accordance with Standard Mil-Std-105 for ordinary inspection. The acceptable quality levels (AQL) shall be as specified in table IX. Major and minor defects shall be as defined in Standard Mil-Std-105.

TABLE IX. Group A inspection

Examination or test	Requirement paragraph	Method paragraph	AQL percent defective Major	Minor
Visual and mechanical examination		4.6.1	1.0	4.0
Materials	3.2			
Body dimensions				
Design and construction (other than body dim.)	3.3 to 3.4 inc.			
Marking[1]	3.16			
Workmanship	3.17			
Insulation resistance (at 25°C)	3.5	4.6.3	1.0	
Capacitance	3.6	4.6.4		
Dissipation factor	3.7	4.6.5		

[1]Marking defects are based on visual examination only and shall be charged only for illegible, incomplete, or incorrect marking. Any subsequent electrical defects shall not be used as the basis for determining marking defects.

4.5.1.3.2 Resubmitted lots.- If an inspection lot is rejected, the supplier may replace it with a new lot, rework it to correct the defects, or screen out defective units, and resubmit it for inspection. Resubmitted lots shall be kept separate from new lots and shall be clearly identified as resubmitted lots. Resubmitted lots shall be inspected, using tightened inspection.

4.5.1.4 Group B inspection.- Group B inspection shall consist of the tests specified in table X, and shall be performed on sample units that have passed the group A inspection. A different set of sample units shall be selected for each subgroup and shall be tested in the order shown.

TABLE X. Group B inspection

Test	Requirement paragraph	Method paragraph
Subgroup 1		
Barometric pressure (flashover)	3.8	4.6.6
Vibration	3.9	4.6.7
Temperature and immersion cycling	3.11	4.6.9
Subgroup 2		
Insulation resistance (at high test temperature)	3.5	4.6.3
Life	3.14	4.6.13

4.5.1.4.1 Sampling plan.- The sampling plan shall be in accordance with Standard Mil-Std-105 for small-sample inspection. Unless otherwise specified herein, normal inspection shall be used at the start of the contract. Small-sample reduced inspection shall be R-1. The AQL shall be 2.5 (percent defective), and the inspection level shall be L8 for normal and tightened inspection and L6 for reduced inspection.

4.5.1.4.2 Disposition of sample units.- Sample units which have been subjected to group B inspection shall not be delivered on the contract or order.

4.5.1.4.3 Resubmitted lots.- If an inspection lot is rejected due to failure to pass group B inspection, the lot shall not be resubmitted to the Government; however, if nonconformance of the lot is due to conditions which will not affect the useability or performance of capacitors, the lot may be resubmitted if remedial action has been taken.

4.5.1.5 Group C inspection.- Group C inspection shall consist of the tests specified in table XI, in the order shown. They shall be performed on sample units that have passed the group A inspection. Shipment shall not be held up pending completion of the inspection.

TABLE XI. roup C inspection

Test	Requirement paragraph	Method paragraph	Number of sample units to be tested	Number of defectives allowed[1]
Initial production and every month				
Moisture resistance	3.12	4.6.10	6	1
Initial production and every 2 months				
Low ambient temperature	3.13	4.6.12	6	1
Salt spray (corrosion)	3.10	4.6.8		

[1] A specimen having one or more defects will be considered as one defective.

4.5.1.5.1 Sampling plan.- Sample units shall be selected as specified in 4.5.1.5.1.1 and 4.5.1.5.1.2 from the initial production, processed for acceptance at the start of the contract, and thence from each month's and each 2-month's production in accordance with table XI. A different set of sample units shall be selected for each group of tests. If the number of defectives exceeds those allowed in table XI, the sample shall be considered to have failed.

4.5.1.5.1.1 Initial production and every month.- During the initial production and thence once each calendar month, sample units of the same style shall be selected irrespective of characteristic, voltage, and capacitance.

4.5.1.5.1.2 Initial production and every 2 months.- During the initial production and thence every 2 months, sample units of the same style shall be selected in each characteristic, irrespective of voltage and capacitance. These sample units may be in any capacitance tolerance.

4.5.1.5.2 Noncompliance.- If a sample fails to pass group C inspection, the supplier shall take corrective action on the process and on all units of product which can be corrected and which were manufactured under the same conditions and with the same materials, processes, etc., and which are considered subject to the same failure. Acceptance inspection shall be discontinued until corrective action has been taken, additional sample units shall be subjected to Group C inspection (all inspections, or the inspections which the sample failed, at the option of the Government). Production inspection, and groups A and B inspection may be reinstituted; however, final acceptance shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer.

4.5.1.5.3 Disposition of sample units.- Sample units which have been subjected to group C inspection shall not be delivered on the contract or order.

4.5.2 Inspection of preparation for delivery.- Sample items and packs shall be selected and inspected in accordance with Specification Mil-P-116 to verify conformance with requirements in section 5 of this specification.

4.6 Methods of examination and test.

4.6.1 Visual and mechanical examination.- Capacitors and brackets shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements. (See 3.2 to 3.3.2.1 inclusive.)

4.6.2 Dielectric withstanding voltage.- Unless otherwise specified, this test shall be performed in accordance with paragraph 3.4. The surge current shall be limited to between 5 milliamperes and 1 ampere. Where necessary, a suitable current-limiting resistor shall be inserted into the circuit. At least 95 percent of the specified potential shall appear across the terminals of the capacitor prior to and during the period of time specified.

4.6.2.1 The dielectric withstanding voltage after temperature and immersion cycling and moisture resistance tests as specified in 4.6.9 and 4.6.10 respectively shall be 175 percent of rated d.c. voltage.

4.6.2.2 For acceptance testing, the period of test voltage application (terminal to terminal), at the option of the supplier, shall be either 200% of rated d.c. voltage for a period of 15 seconds or 250% of rated d.c. voltage for not less than 1 second.

4.6.2.3 For acceptance testing, the period of test voltage application (terminal to case) shall be 1 second.

4.6.3 Insulation resistance (see 3.5.1).- Capacitors shall be tested in accordance with method 302 of Standard Mil-Std-202. The following details shall apply:

(a) Test potential -A potential equal to the 40°C rated dc voltage or 500 volts dc, whichever is less, shall be applied.

(b) Points of measurement:

1. Terminal to terminal-- Insulation resistance shall be measured between terminals at the applicable high-test temperature specified in table III and at 25°C, or corrected thereto. For acceptance inspection, the measurement at the high-test temperature is required only for specimens which will be subjected to the life test.

2. Terminal to case-- When the case is not a terminal, the measurement of insulation resistance shall be made between each terminal and the case at 25°C, or corrected thereto.

4.6.4 Capacitance (see 3.6).- Capacitors shall be tested in accordance with method 305 of Standard Mil-Std-202. The following details shall apply:

(a) Test frequency 1,000 $\pm$ 100 cps for capacitors whose nominal capacitance does not exceed 1 microfarad and whose rated dc voltage does not exceed 3,000 volts. For capacitors not within these limits, measurements shall be made at a frequency of 60 $\pm$6 cps.

(b) Limit of accuracy.- Shall be within $\pm$ 2 percent.

4.6.5 Dissipation factor.- The dissipation factor of each capacitor shall be measured at a voltage not greater than 20 percent of the rated dc voltage. If the nominal capacitance does not exceed 1 microfarad and if the rated dc voltage does not exceed 3,000 volts, measurement shall be made at a frequency of 1,000 $\pm$ 100 cps. Measurements on capacitors not within these limits shall be made at a frequency of 60 $\pm$ 6 cps.(See 3.7.)

4.6.6 Barometric pressure (flashover).- Capacitors shall be tested in accordance with method 105 of Standard Mil-Std-202. The following details and exceptions shall apply:

(a) Method of mounting -- Capacitors shall be mounted by suitably clamping their leads.

(b) Test - condition B -- Unless otherwise specified. (See Figure 1 for flashover voltage versus altitude.

(c) Tests during subjection to reduced pressure -- Unless otherwise specified (see 3.8), a potential equal to 125 percent of rated dc voltage shall be applied for at least 1 minute between each terminal and every other terminal in turn and between the case and each terminal not connected to the case. A suitable means shall be used to detect momentary or permanent breakdown.

4.6.7 Vibration (see 3.9).

4.6.7.1 High frequency.- Capacitors shall be tested in accordance with method 204 of Standard Mil-Std-202. The following details and exceptions shall apply:

(a) Mounting of specimens -- Capacitors shall be rigidly mounted by the body to a vibration-test apparatus. Wire-lead capacitors shall be secured $1/2 \pm 1/8$ inch from the case.

(b) Test condition -- B.

(c) Duration and direction of motion -- 4 hours in each of two mutually perpendicular directions (total of 8 hours), one parallel and the other perpendicular to the cylindrical axis.

(d) Measurements during vibration -- During the last cycle in each direction, an electrical measurement (see 6.7) shall be made to determine intermittent contacts or open circuiting or short circuiting.

(e) Measurements after vibration -- Not applicable.

4.6.8 Salt spray (corrosion)- Capacitors and brackets shall be tested in accordance with method 101, test condition B, of Standard Mil-Std-202. After this test, capacitors and brackets shall be examined for evidence of corrosion, unwrapping of or mechanical damage to insulating sleeves and obliteration of marking.

4.6.9 Temperature and immersion cycling (see 3.11).

4.6.9.1 Temperature cycling.- Capacitors and brackets shall be tested in accordance with method 102 of Standard Mil-Std-202. The following details and exceptions shall apply:

(a) Conditioning prior to first cycle -- 15 minutes at room ambient temperature.

(b) Test condition -- D, except that in step 3, specimens shall be tested at the applicable high ambient test temperature (see table III).

(c) Measurements before and after cycling -- Not applicable.

4.6.9.2 Immersion cycling.- Following temperature cycling, capacitors and brackets shall be tested in accordance with method 104 of Standard Mil-Std-202. The following details and exceptions shall apply:

(a) Test-condition letter -- C, except that the duration of each immersion shall be 30 minutes. Change from one solution to the other shall be made in not more than 3 seconds.

(b) Measurements after cycling -- within 5 hours after removal from bath, insulation resistance and dielectric withstanding voltage, shall be measured as specified in 3.5.1 and 4.6.2.1. The external case shall be examined for corrosion.

4.6.10 Moisture resistance (see 3.12).- Capacitors and brackets shall be tested in accordance with method 106 of Standard Mil-Std-202. The following details and exceptions shall apply:

(a) Mounting -- Capacitors shall be securely fastened by normal mounting means, except during measurement. (Wire-lead capacitors shall be secured $1/2 \pm 1/8$ inch from the case.)

(b) Initial measurements -- Not applicable.

(c) Polarization voltage -- 100 volts shall be applied across the terminals of 50 percent of the capacitors. No potential shall be applied to the remaining 50 percent of the capacitors.

(d) Loading voltage -- Not applicable.

(e) During step 7, capacitors shall be removed from the humidity chamber at the same time each day.

(f) Final measurements -- insulation resistance and dielectric withstanding voltage shall be measured as specified in 3.5.1 and 4.6.2.1, respectively.

(g) Visual examination -- After this test, capacitors and brackets shall be visually examined for corrosion and obliteration of marking.

4.6.11 Seal (see 3.15).

4.6.11.1 The capacitors, while at room ambient temperature, shall be immersed in oil at 125°C for a minimum of 1 minute.

4.6.12 Low ambient temperature. (See 3.13.)

4.6.12.1 Low ambient temperature.- Capacitors shall be placed in a chamber maintained at -55°C ± 3°C and rated dc voltage shall be applied at this condition for 48 ± 4 hours. The air within the condition chamber shall be circulated.

4.6.13 Life.- Unless otherwise specified, capacitors shall be subjected to a life test at 140% of rated voltage at 200°C for a period of 1000 ± 8 hours. During the test, capacitors shall be separated by a distance of not less than 1 inch. Adequate circulation of air shall be provided to prevent the temperature within 6 inches of any capacitor from departing more than ± 3°C from the nominal ambient temperature of the chamber. The surge current shall be limited to between 5 milliamperes and 1 ampere. Where necessary, a suitable current-limiting resistor shall be inserted into the circuit. For the life test, a group of capacitors totaling not more than 20 microfarads shall be connected in series with the above indicated resistors, the resistor capacitor combination connected in parallel, and this group connected in series with a register circuit. This register circuit shall not record momentary voltage change across the capacitors of .4 volts or less but shall record values of .5 volts above. After the test, capacitors shall be returned to standard test conditions and the insulation resistance and capacitance shall be measured as specified in 4.6.3 and 4.6.4, respectively. (See 3.14.)

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging (see 6.1).

5.1.1 Level A.- Capacitors shall be individually protected and unit-packaged in accordance with method III of Specification Mil-P-116. Capacitors shall be classified according to the terminals symbols specified in table I.

5.1.1.1 Terminal-A capacitors.- Terminal-A capacitors shall be cushioned and packaged in 30-pound kraft paper envelopes, sealed. Unless otherwise specified (see 6.1), five unit packages or a multiple thereof shall be further packaged in intermediate containers conforming to Specification PPP-B-566, PPP-B-665, or PPP-B-676. The gross weight of the intermediate container shall not exceed 10 pounds.

5.1.2 Level C.- Capacitors shall be afforded preservation and packaging in accordance with the supplier's normal commercial practice.

5.2 Packing (see 6.1).

5.2.1 Level A.- Capacitors packaged as specified (see 6.1) shall be packed in overseas-type wirebound wood, wood-cleated fiberboard, wood-cleated plywood, nailed wood, fiber (class 2 or 3, as specified (see 6.1)), or wood-cleated paper-overlaid boxes conforming to Specifications PPP-B-585, PPP-B-601, PPP-B-621, PPP-B-636, and Mil-B-10377, respectively, at the option of the supplier. Shipping containers shall have case liners conforming to Specification Mil-L-10547; the case liners shall be closed and sealed in accordance with the appendix thereto. Case liners for boxes conforming to Specification PPP-B-636 may be omitted provided the center and edge seams and suppliers' joints are sealed with tape, at least 1 1/2 inches wide, conforming to Specification PPP-T-76. Box closures and strapping shall be as specified in the applicable box specification and appendix thereto. Fiber boxes conforming to Specification PPP-B-636 may be banded with tape conforming to type IV of Specification PPP-T-97 and appendix thereto in lieu of steel straps. The gross weight of wood boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable box specifications.

5.2.2 Level B.- Capacitors packaged as specified (see 6.1) shall be packed in domestic-type wirebound wood, wood-cleated fiberboard, wood-cleated plywood, nailed wood, fiber (class 1 or 2,

as specified (see 6.1)), or wood-cleated paper-overlaid boxes conforming to Specification PPP-B-585, PPP-B-591, PPP-B-601, PPP-B-621, PPP-B-636 and Mil-B-10377, respectively, at the option of the supplier. Box closures shall be as specified in the applicable box specification or appendix thereto. The gross weight of wood boxes shall not exceed 200 pounds; fiberboard boxes shall not exceed the weight limitations of the applicable box specification.

5.2.3 Level C.- Capacitors packaged as specified (see 6.1) shall be packed in containers of the type, size and kind commonly used for the purpose, in a manner that will insure acceptance by common carrier and safe delivery at destination. Shipping containers shall comply with the Uniform Freight Classification Rules or regulations of other carriers as applicable to the mode of transportation.

5.2.4 General.- Insofar as possible and practicable, exterior containers shall be uniform in shape and size, shall be of minimum cube and tare consistent with the protection required, and shall contain identical quantities of identical items.

5.3 Marking.- In addition to any special marking required by the contract or order, unit packages, intermediate packages and exterior shipping containers shall be marked in accordance with Standard Mil-Std-129. (See 6.1.)

6. NOTES

6.1 Ordering data.- Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Title, number and date of the applicable detail specification and the complete type designation.
(c) Levels of preservation and packaging and packing and applicable marking. (See sect.5.)
(d) Number of unit packages if other than that specified in 5.1.1.1.
(e) Class of fiber. (See 5.2.1 and 5.2.2.)

6.1.1 Indirect shipment.- The packaging, packing and marking specified in section 5 applies only to direct purchases by or direct shipment to the Government and are not intended to apply to contracts or orders between the manufacturer and prime contractor.

6.2 Government verification inspection.- Verification inspection by the Government will be limited to the amount deemed necessary to determine compliance with the contract or order, and will be limited in severity to the definitive quality assurance provisions established in this specification and the contract or order. The amount of verification inspection by the Government will be adjusted to make maximum utilization of the supplier's quality control system and the quality history of the product. (See 4.1.2.).

6.3 DC Capacitors.- The energy content of a dc capacitor when fully charged is determined by the following formula:

$$W = \frac{CE^2}{2}$$

Where:

W = energy content in watt-seconds.

C = nominal capacitance in farads.

E = dc voltage rating in volts at 40°C.

6.4 DC voltage.- A dc voltage is an undirectional voltage in which the changes in value are either zero or so small that they may be neglected. (See 1.2.1.6.)

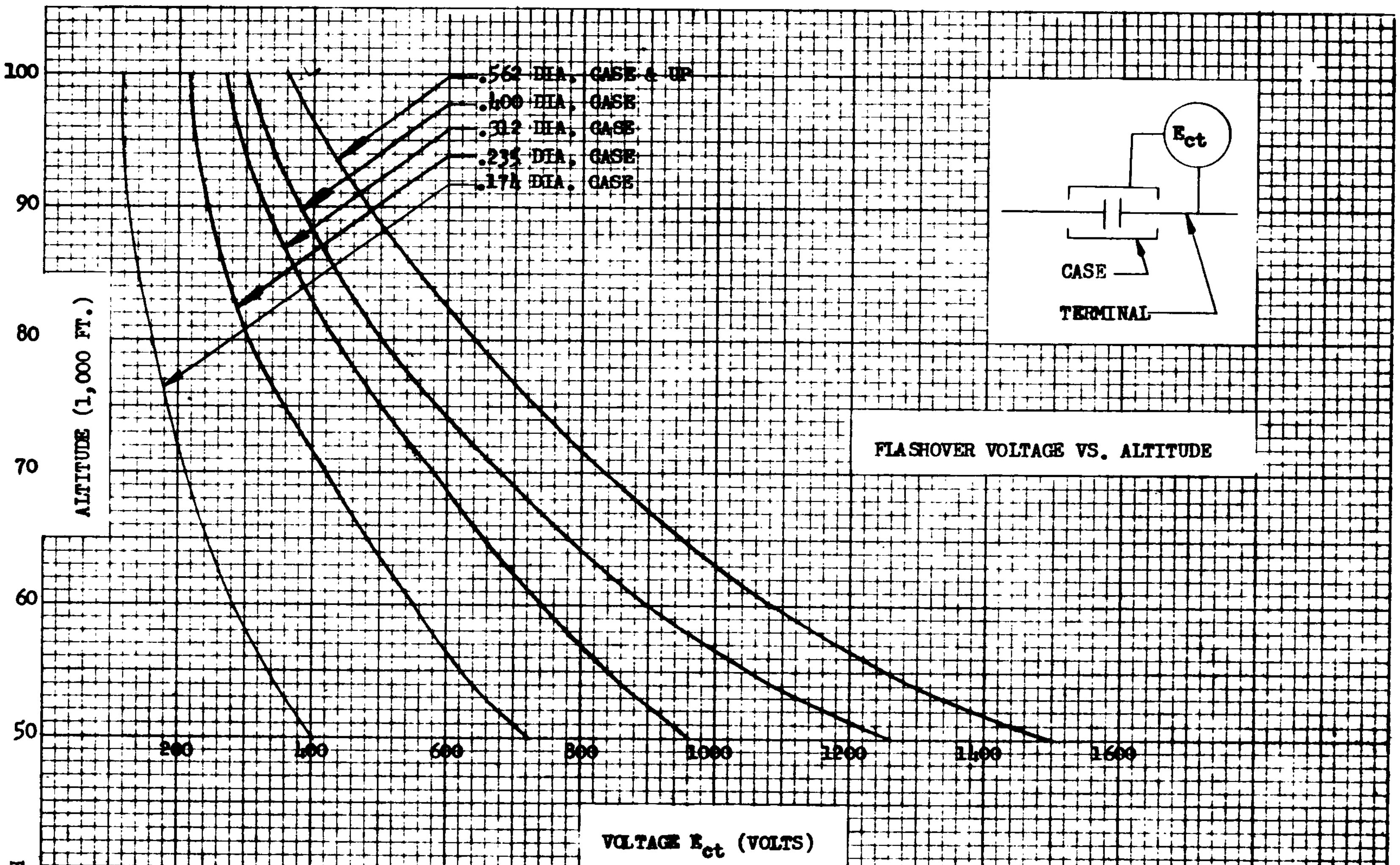
6.5 Noninductive construction.- Noninductive construction means a construction which reduces, but usually does not eliminate completely, the effective inductance of the capacitor. This result is obtained by so routing the currents in the electrodes that the magnetic fields tend to cancel each other, or by making the current paths very short. (See 3.3.2.1.)

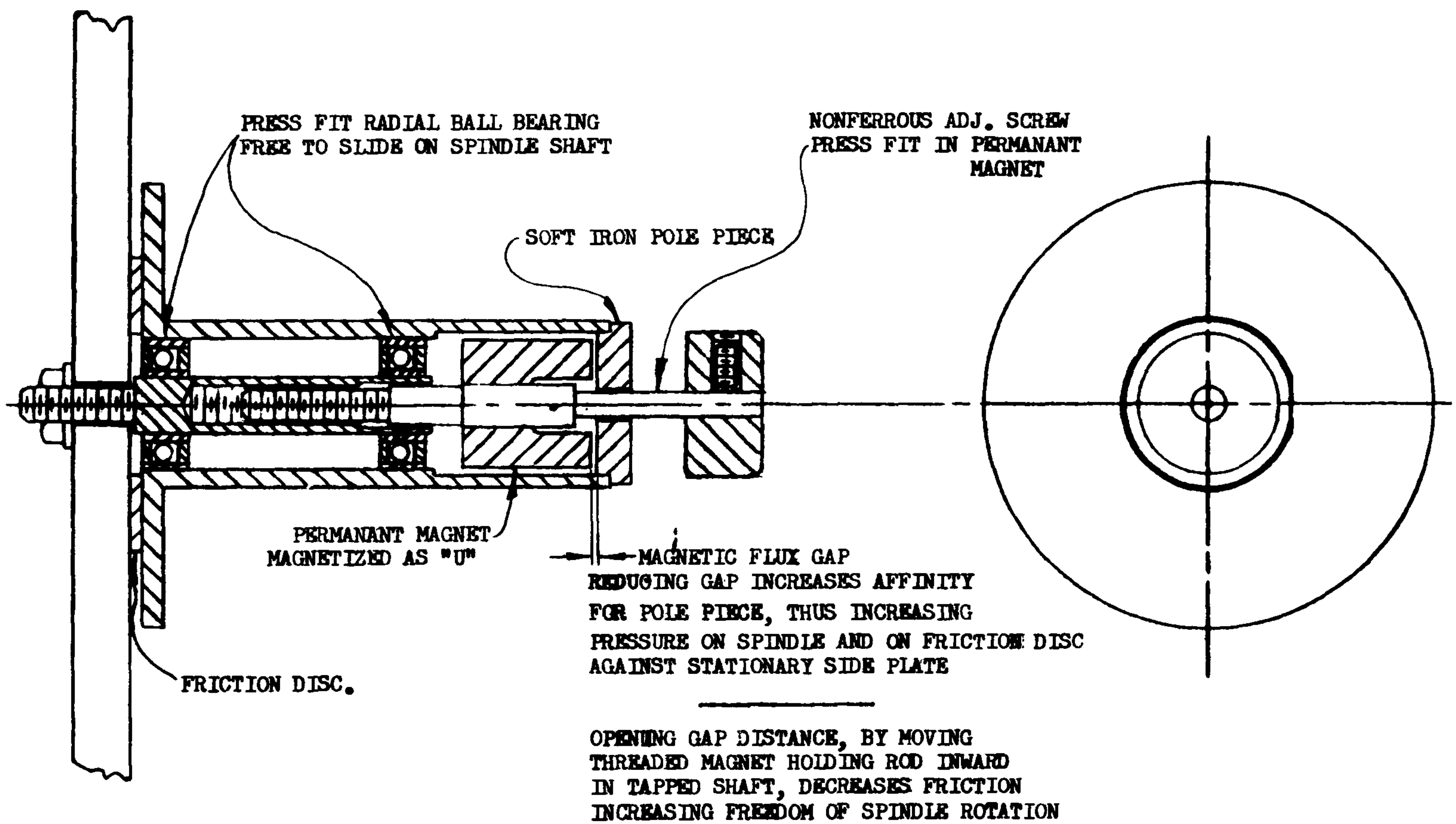
6.6 Nonmagnetic-case capacitor- A nonmagnetic-case capacitor is a capacitor in which no part of the case or bracket is made of magnetic material.

6.7 Vibration (final measurement).- During the last 30 minutes of vibration in each direction, a signal of 1 $\pm$ 0.2 kilocycles per second at a level of 1 $\pm$ 0.2 volts should be placed across the capacitor and measured with a suitable alternating current recording device for the purpose of determining the presence of open circuits, short circuits, or intermittent contacts.

Notice.- When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

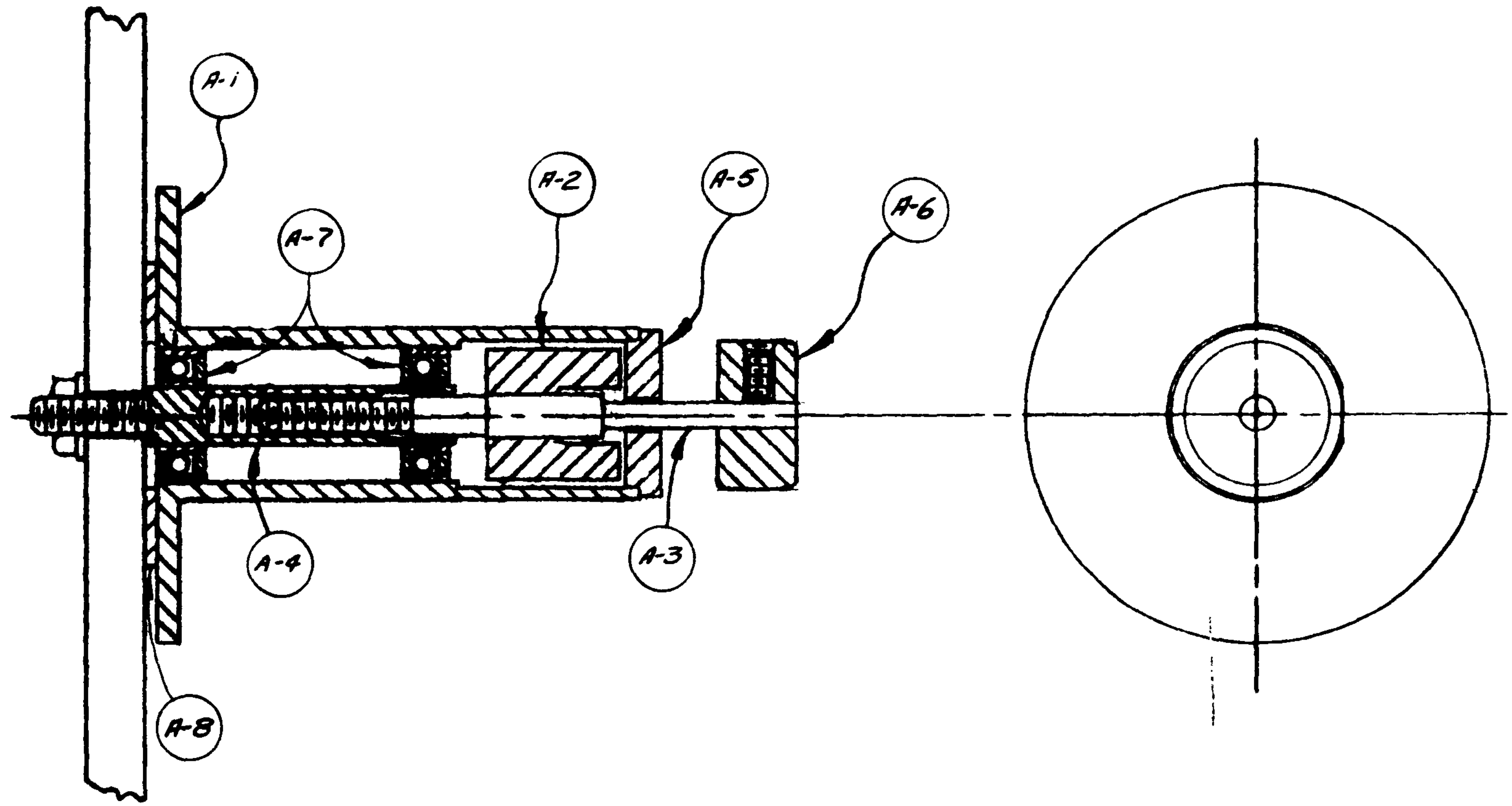
DEARBORN GRAPH 88862-73G-000





DEARBORN ELECTRONIC LABORATORIES, INC
ORLANDO, FLORIDA

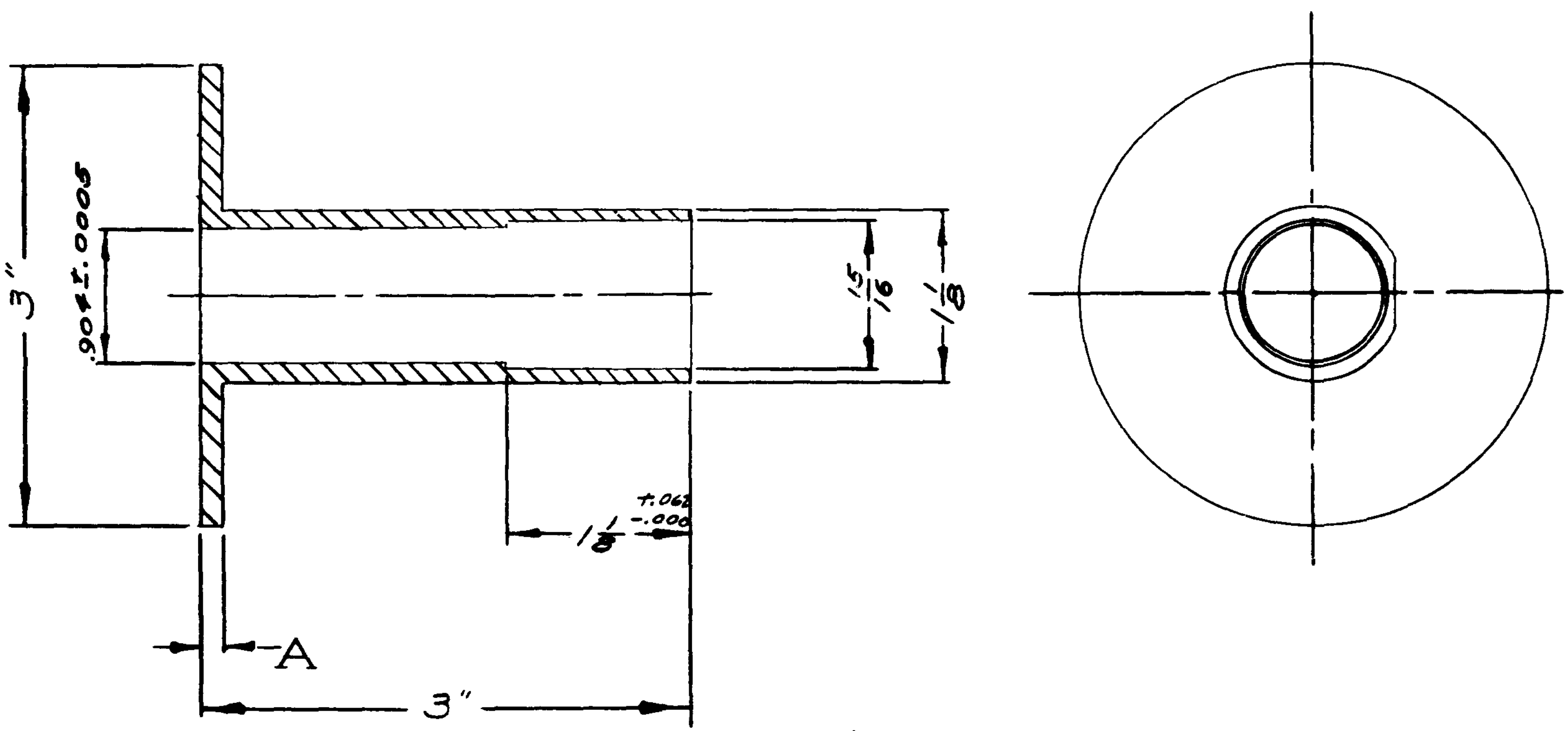
FIGURE 1



DEARBORN ELECTRONIC LABORATORIES			
DRAWN BY G. L.	DATE 8-10-59	APPROVED	DATE
TITLE SPINDLE CLUTCH ASSEMBLY			PART NO. A-10

FIGURE 2.

POSITION	"A" ±
1	7/64
2	1/16
3	7/64
4	5/32

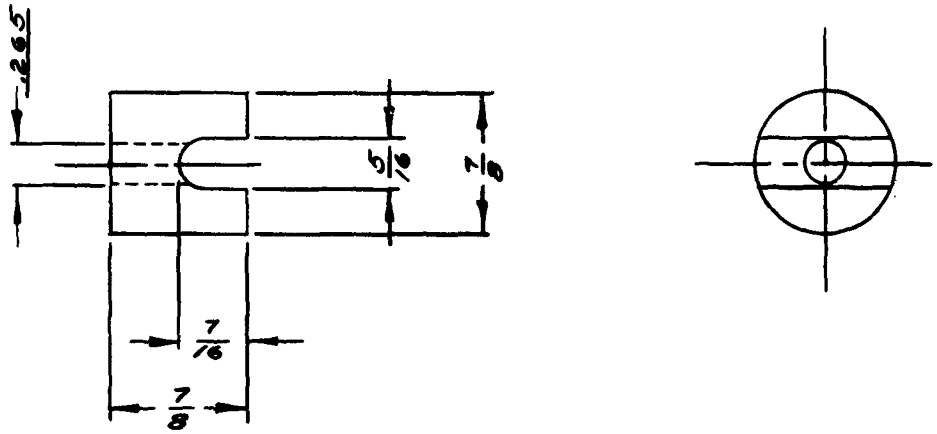


MATERIAL: ALUMINUM

DEARBORN ELECTRONIC LABS			
TITLE SPINDLE		PART NO A-1	
DRAWN BY H. Hauser	DATE 8-10-53	APPROVED	DATE

FIGURE 3

FIGURE 4



PURCHASED FROM
GENERAL ELECTRIC
G.E. PART NO. 5U33B

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DATE	LOC.	REVISION

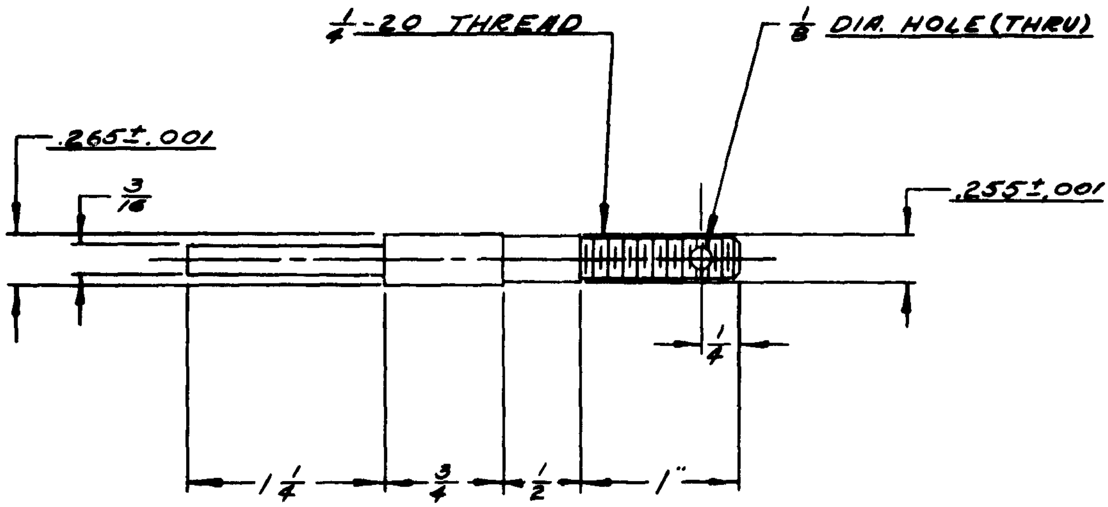
DEARBORN ELECTRONIC LABORATORIES

NO. A-2

TITLE MAGNET

DRAWN W.I.	DATE 8-6-59	ISSUE
APPROVED	DATE	DESIGNER

Form Dea 20



MATERIAL: HARD BRASS

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

NO. A-3

TITLE ADJUSTMENT SCREW

DRAWN	DATE 8-3-59	ISSUE
APPROVED	DATE	DESIGNER

FIGURE 5

FIGURE 5

Form Dea 20

FIGURE 6

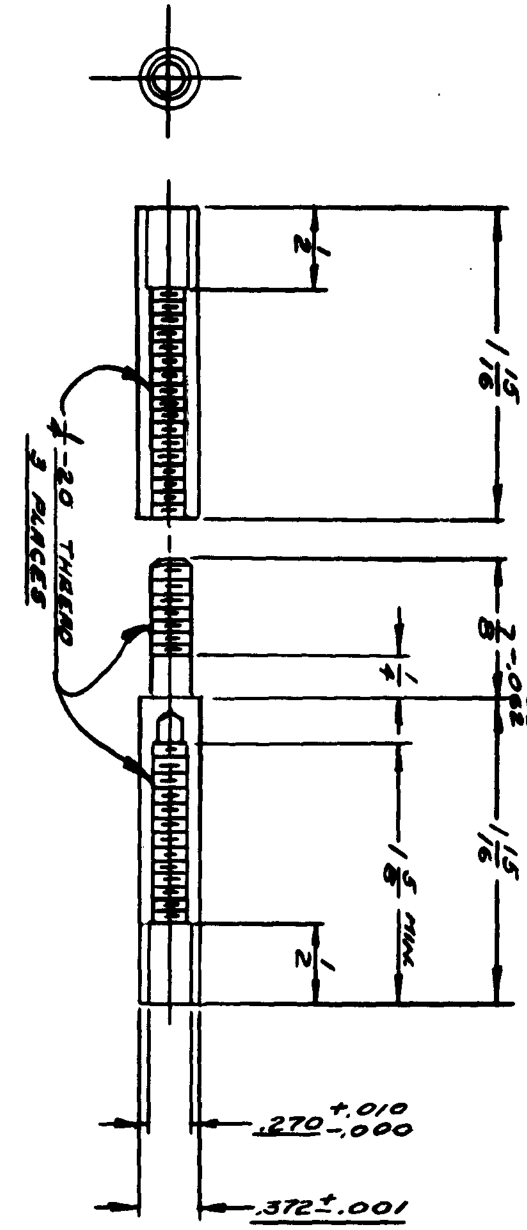


FIGURE 6

NOTE:
SURFACES MUST BE SMOOTH & POLISHED

MATERIAL: C.R.S.

TOLERANCES ARE ±1/64 UNLESS SPECIFIED

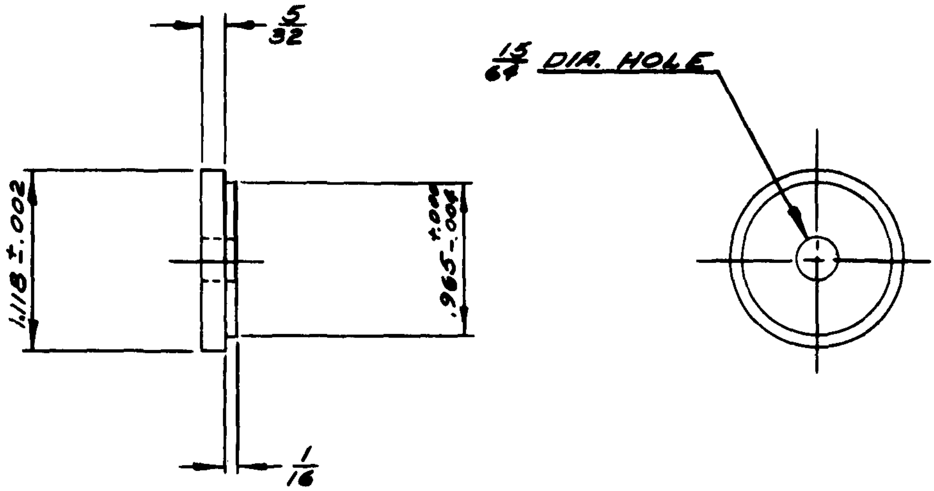
NOTE: THE TERMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES			NO. A-4
TITLE SPINDLE			
DRAWN H.L.	DATE 8-10-59	ISSUE	
APPROVED	DATE	DESIGNER	

Form Dea 20

FIGURE 7



MATERIAL: COLD ROLLED STEEL

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

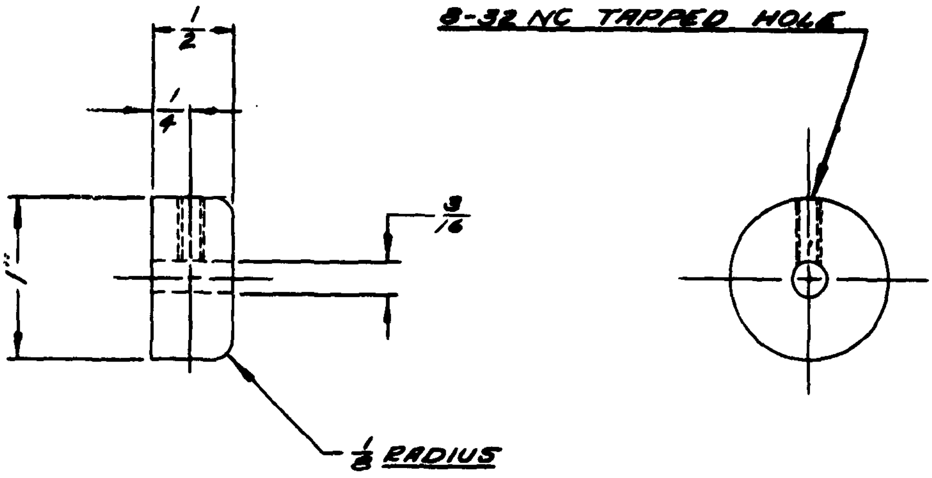
NO. A-5

TITLE WASHER

DRAWN H.J.	DATE 8-3-59	ISSUE
APPROVED	DATE	DESIGNER

Form Dea 20

FIGURE 7



MATERIAL: BAKELITE

FIGURE 8

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

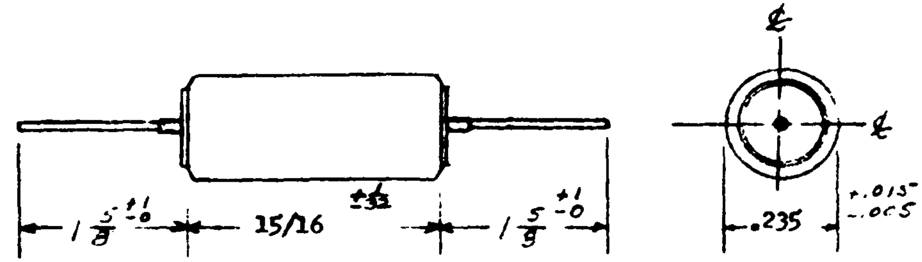
TITLE BAKELITE KNOB

DRAWN H.A.	DATE 8-3-59	ISSUE
APPROVED	DATE	DESIGNER

No. A-8

Form Dea 20

FIGURE 8



4) FUSED-ELECTRO-PLATE CASE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDING

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER

RATED .001 MFD		HIGH .00105	LOW .00095	
LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	1/2	.0005	Met Teflon	54.16 ft. (1)
1/2	1/2	.001	Teflon	54.16 ft. (1)
1/2	7/16	.0002	Al Foil	.0073 Lbs. (1)
1/2	1/2	.0005	Teflon	54.16 ft. (1)
1/2	1/2	.001	Teflon	54.16 ft. (2)
	Diameter .167			

ARBOR (2) 050 | 1/16 MARGIN IN 1/32 OUT | TAB
AFL 6-1/2 (TEST) (2) TURNS 15 (TEST) (2)

IMPREGNATE:
SEAL
BAKE ** 200°C
CURE

LEAK TEST:

$	TO	- $
5$ .00105	TO .00095	- 5$

J DEARBORN
MTF102J1
.001 Mfd
100 VDC

$	TO	- $
$	TO	- $

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202- 57	TUBE
2	1616- 3	END SEAL
2	1801- 1	PIGTAILS
	TEFLON WRAP	

TEST INFORMATION	
W.V.D.C.	100
T.T.	200
T.C.	200
D.F	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

DATE	LOC	REVISION
9/22/61		Redesigned
1/18/62	(1)	Was 43.62; 43.62; .006; 43.62
1/18/62	(2)	Was 43.62; 080; 5-1/4; 10

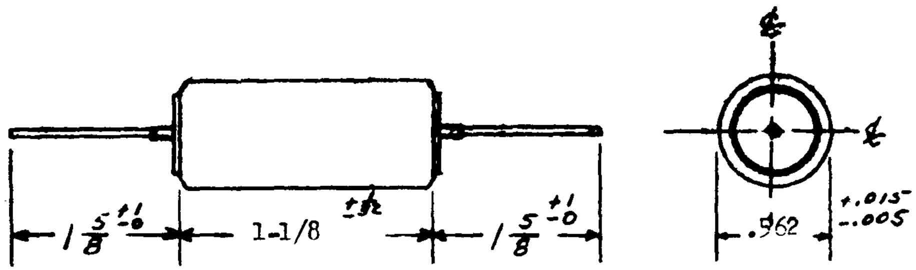
DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

DRAWN BY [signature] DATE 8/11/59
CHECKED BY [signature] ORIGINAL REVISED
TYPE NO: MTF102J1

PRINT NO. 10988-C

Form Dee 10A 22

FIGURE 9



4) FUSED ELECTRO-PLATE CASE
5) USE ALC A 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDING.

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER

RATED .01 MFD		HIGH .0105	LOW .0095	
LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	5/8	.0005	Met Teflon	400 ft.
1/2	5/8	.0005	Teflon	400 ft.
1/2	5/8	.000375	Teflon	400 ft.
1/2	1/2	.0002	Al Foil	.06 lbs.
1	5/8	.0005	Teflon	800 ft.
1/2	5/8	.000375	Teflon	400 ft.
	Diameter .423			

ARBOR .080 | MARGIN IN 1/8 11/32 OUT | TAB
AFL 48 | TURNS 60

IMPREGNATE:
SEAL
BLEED
CURE

LEAK TEST:

± $	TO	- $
±5 $ .0105	TO .0095	- 5 $
J DEARBORN MTF103J10 .01 Mfd 1000 VDC		
± $	TO	- $
± $	TO	- $

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202-7	TUBE
2	1617-6	END SEAL
2	1801-5	PIGTAILS
	TEFLON WRAP	

DATE	LOC	REVISION
9/22/61		Redesigned

TEST INFORMATION

W.V.D.C.	1000
T.T.	2000
T.C.	2000
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

DRAWN BY | DATE 8/11/61
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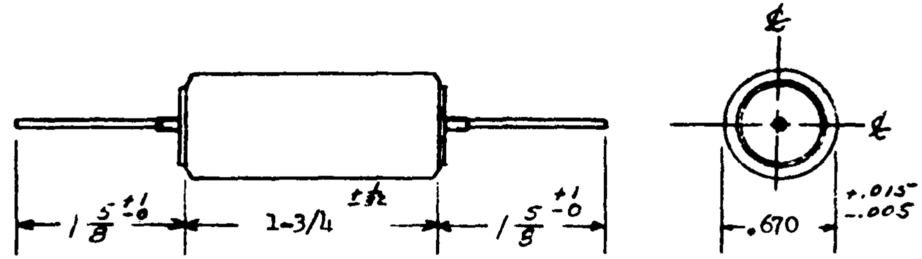
TYPE NO: MTF103J10

PREP. NO. 10995-B

Form Dea. 10A 22

FIGURE 10



4) FUSED ELECTRO-PLATE CASE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDING.

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER

RATED .047 MFD HIGH .049 LOW .04465

LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	1-3/8	.0005	Met Teflon	667 ft.
1/2	1-3/8	.0005	Teflon	667 ft.
1/2	1-3/8	.000375	Teflon	667 ft.
1/2	1-1/4	.0002	Al Foil	.221 lbs.
1	1-3/8	.0005	Teflon	1344 ft.
1/2	1-3/8	.000375	Teflon	667 ft.
	Diameter .534			

ARBOR .080	MARGIN IN 1/8	1/32 OUT	TAB
AFL 72-1/2		TURNS 74	

IMPREGNATE:
SEAL
BLEED - 200°C
CURE

LEAK TEST:

TEST INFORMATION	
W.V.D.C.	1000
T.T.	2000
T.C.	2000
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

+ $	TO - $
- 5% .04935	TO .04465 - 5%
J	DEARBORN MTF473J10 .047 Mfd 1000 VDC
+ $	TO - $
+ $	TO - $

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202- 134	TUBE
2	1617- 7	END SEAL
2	1801- 4	PIGTAILS
	TEFLON WRAP	

DATE	LOC	REVISION
9/22/61		Redesigned

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ORLANDO, FLORIDA

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TYPE NO: MTF473J10

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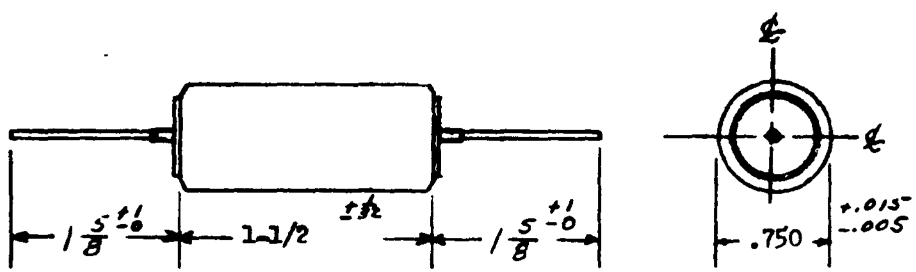
FIGURE 11



NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER
4) FUSED ELECTRO-PLATE CASE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDING.

RATED .1 MFD		HIGH .105	LOW .095	
LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	1-1/8	.0005	Met Teflon	1392 ft.
1/2	1-1/8	.0005	Teflon	1392 ft.
1/2	1	.0002	Al Foil	.363 lb.
1	1-1/8	.0005	Teflon	2784 ft.
	Diameter .66			

ARBOR 080	MARGIN 1/8 IN 1/32 OUT	TAB	
AFL 149		TURNS 127	

IMPREGNATE:
SEAL
BLEED -- 200°C
CURE

LEAK TEST:

+ $	TO	- $
- 5$ .105	TO .095	- 5$
J DEARBORN MTF104J6 .1 Mfd 600 VDC		
+ $	TO	- $
+ $	TO	- $

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202- 143	TUBE
2	1[illegible]7- 8	END SEAL
2	1801- 6	PIGTAILS
	TEFLON WRAP	

TEST INFORMATION	
W.V.D.C.	600
T.T.	1200
T.C.	1200
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

DATE	LOC	REVISION
9/22/61		Redesigned

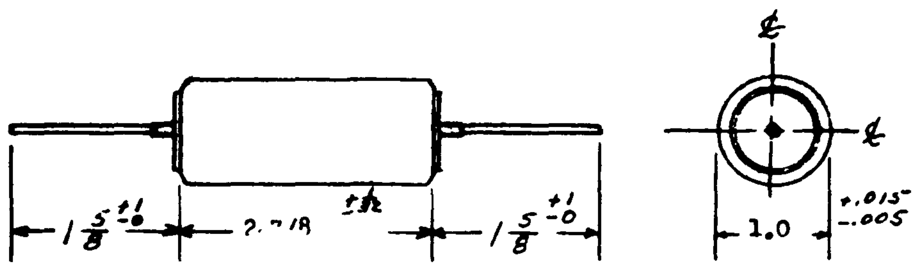
DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

DRAWN BY	DATE 8/11/59
CHECKED BY	ORIGINAL REVISED
TYPE NO: MTF104J6	

PRINT NO. 10993-B

Form Des 10A 27

FIGURE 12



4) FUSED ELECTRO-PLATE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON ON END OF WINDING.

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER

RATED .47 MFD HIGH .4935 LOW .4465

LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	2-1/2	.0005	Met Teflon	2245 ft.
1/2	2-1/2	.0005	Teflon	2245 ft.
1/2	2-3/8	.0002	Al Foil	1.48 lbs
1	2-1/2	.0005 (1)	Teflon	4490 Ft.
	Diameter .855		(3)	

ARBOR 1/8 (3) 1/8 — MARGIN IN 1/32 OUT — TAB

AFL 255 — TURNS 165 (3)(2)

IMPREGNATE:
SEAL
BLEED -- 200°C
CURE

LEAK TEST:

- $ TO - $

- 5$ .4935 TO .4465 - 5$

J DEARBORN
MTF474J6
.47 Mfd
600 VDC

- $ TO - $

- $ TO - $

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202-142	TUBE
2	1617-9	END SEAL
2	1801-6	PIGTAILS
	TEFLON WRAP	

TEST INFORMATION	
W.V.D.C.	600
T.T.	1200
T.C.	1200
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

DATE	LOC	REVISION
9/22/61		Redesigned
11/17/61	(1)	Added 1L. 2-1/2 X .0005 Teflon
11/17/61	(2)	Was 260
1/18/62	(3)	Was .734; 080; 145

DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

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TYPE NO: MTF474J6

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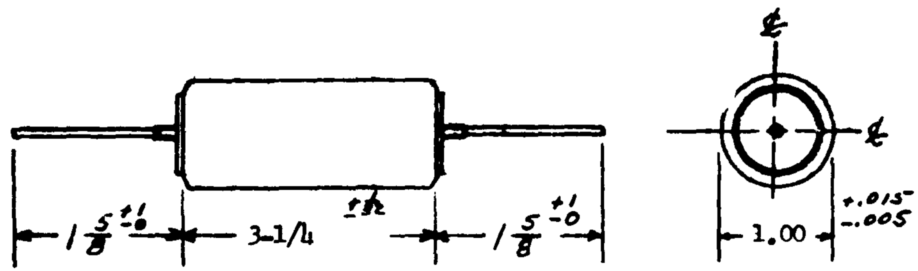
Form Dea 10A 22

FIGURE 13



4) FUSED ELECTRO-PLATE CASE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDINGS

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER

RATED 1.0 MFD		HIGH 1.05	LOW .95	
LAYER	WIDTH	THICKNESS	MATERIAL	CWT
1/2	2-7/8	.000375	Met Teflon	2892 ft.
1/2	2-7/8	.000375	Teflon	2892 ft.
1/2	2-13/16	.0002	Al Foil	2.28 lbs
1	2-7/8	.000375	Teflon	5784 ft.
	Diameter	.858	(1)	

ARBOR 1/8 (1) MARGIN 1/16 IN 1/32 OUT TAB

AFL 332 TURNS 214 (1)

IMPREGNATE:
SEAL
BLEED
CURE

LEAK TEST:

◆	$	TO	-	$
◆ 5$	1.05	TO	.95	- 5$
J	DEARBORN MTF105J4 1.0 Mfd 400 VDC			
◆	$	TO	-	$
◆	$	TO	-	$

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202- 141	TUBE
2	1617- 9	END SEAL
2	1801- 6	PIGTAILS
	TEFLON WRAP	

DATE	LOC	REVISION
9/22/61		Redesigned
1/18/62	(1)	Was .869; 080; 224

TEST INFORMATION	
W.V.D.C.	400
T.T.	800
T.C.	800
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

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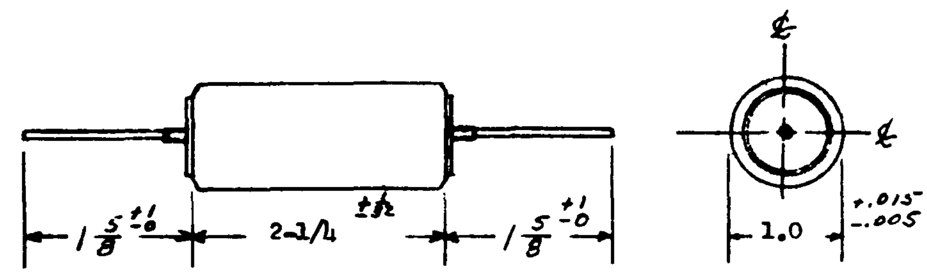
TYPE NO: MTF105J4

PRINT NO. 10991-C

Form Eng 104 29

FIGURE 14



4) FUSED ELECTRO-PLATE CASE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDINGS

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER

RATED 2.0 MFD		HIGH 2.1	LOW 1.9	
LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	1-7/8	.000375	Met Teflon	4706 ft.
1/2	1-7/8	.000375	Teflon	4706 ft.
1/2	1-13/16	.0002	Al Foil	2.28 lbs
	Diameter .818			

ARBOR 080	MARGIN 1/16 IN 1/32 OUT	TAB
AFL 515		TURNS 367

IMPREGNATE:
SEAL
BAKED-200°C
CURE
LEAK TEST:

-5%	2.1	TO 1.9	-	5%
J	DEARBORN MTF205J2 2.0 Mfd 200 VDC			-
+ %		TO	-	%
+ %		TO	-	%
+ %		TO	- -	%

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202- 125	TUBE
2	1617- 9	END SEAL
2	1801- 6	PIGTAILS
	TEFLON WRAP	

DATE	LOC	REVISION
9/22/61		Redesigned

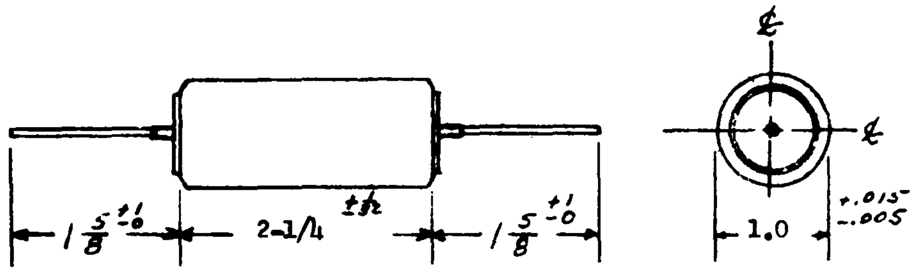
TEST INFORMATION	
W.V.D.C.	200
T.T.	400
T.C.	400
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

DRAWN BY [signature] DATE 8/19/59
CHECKED BY [signature]
TYPE NO: MTF205J2

SHEET NO. 10990-B

Form Dea 10A 77



4) FUSED ELECTRO-PLATE CASE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDINGS

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER

RATED 2.0 MFD	HIGH 2.1		LOW 1.9	
LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	1-7/8	.000375	Met Teflon	4706 ft.
1/2	1-7/8	.000375	Teflon	4706 ft.
1/2	1-13/16	.0002	Al Foil	2.28 lbs
	Diameter .818			

ARBOR 080 | MARGIN 1/16 IN 1/32 OUT | TAB

AFL 515 | TURNS 367

IMPREGNATE:
SEAL
BLEED -200°C
CURE

LEAK TEST:

◆ $	TO	- $
◆ 5$ 2.1	TO 1.9	- 5$
J DEARBORN MTF205J2 2.0 Mfd 200 VDC		
◆ $	TO	- $
◆ $	TO	- $

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202- 125	TUBE
2	1617- 9	END SEAL
2	1801- 6	PIGTAILS
	TEFLON WRAP	

TEST INFORMATION	
W.V.D.C.	200
T.T.	400
T.C.	400
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

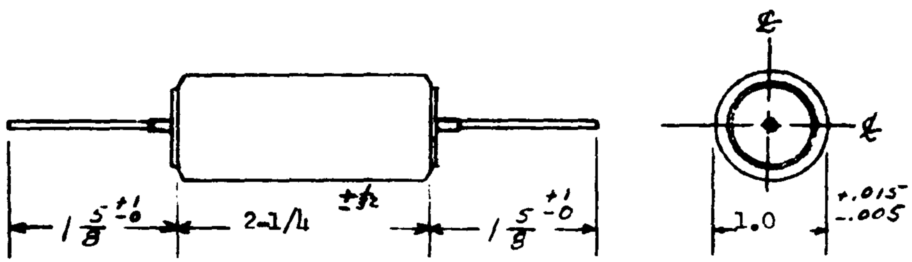
DATE	LOC	REVISION
9/22/61		Redesigned

DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

DRAWN BY | DATE 8/19/59
CHECKED BY | ORIGINAL REVIEWED
TYPE NO: MTF205J2

PRINT NO. 10990-B

Form Dea 10A 27



RATED 4.0 MFD	HIGH 4.2	LOW 3.8		
LAYERS	WIDTH	THICKNESS	MATERIAL	CWT
1/2	1-7/8	.00025	Met Teflon	6958 ft.
1/2	1-7/8	.00025	Teflon	6958 ft.
1/2	1-13/16	.0002 (1)	Al Foil	3.09
	Diameter	.800	(1)	

ARBOR 1/8 (2) | MARGIN IN 1/16 OUT 1/32 | TAB

AFL 700 | TURNS 480 (2)

IMPREGNATE:
SEAL
BAKED 200°C
CURE

LEAK TEST:

NOTE:
1) CRIMP TUBE
2) CRIMP EYELETS
3) USE 95-5 SOLDER
4) FUSED ELECTRO-PLATE CASE
5) USE ALCOA 805 SPRAY ON SECTIONS
6) USE TEFLON TAPE ON END OF WINDINGS

+ % TO - %

+5 % 4.2 TO 3.8 - 5%
J DEARBORN
MTF405J1
4.0 Mfd
100 VDC

+ % TO - %

+ % TO - %

BILL OF MATERIAL

AMT.	PART NO.	ITEM
1	1202-125	TUBE
2	1617-9	END SEAL
2	1801-6	PIGTAILS
	TEFLON WRAP	

TEST INFORMATION	
W.V.D.C.	100
T.T.	200
T.C.	200
D.F.	.5% Max
I.R.	5000 Megs Min at 25°C 500 Megs Min at 200°C

DATE	LOC	REVISION
9/22/61		Redesigned
1/18/62	(1)	Was .002; .825
1/18/62	(2)	Was 980; 104

DEARBORN ELECTRONIC LABORATORIES
ORLANDO, FLORIDA

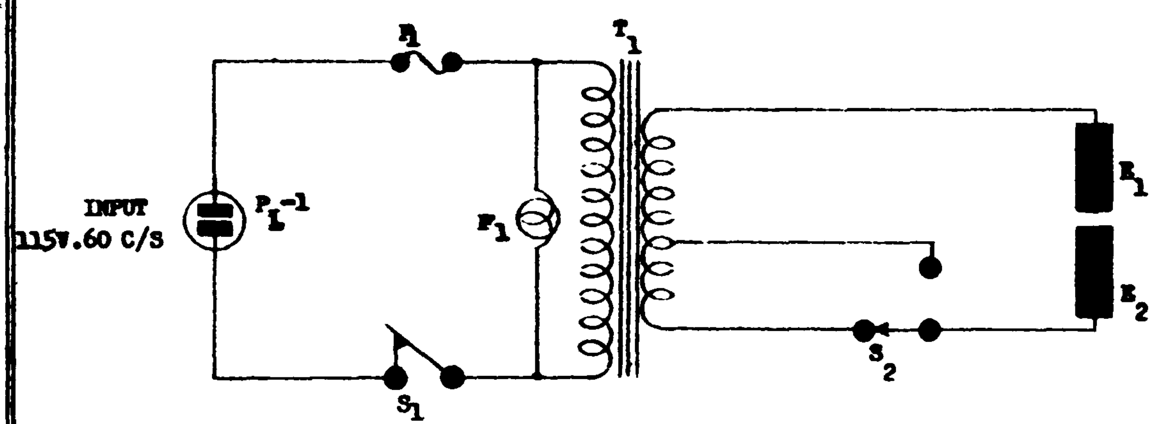
DRAWN BY [illegible] | DATE 6/10/59
CHECKED BY [illegible] | REVISED
TYPE NO: MTF405J1

PRINT NO. 10989-C

Form Den 10A 39

FIGURE 16

POWER SUPPLY
MODEL 2293-C



PART LIST

T_1	TRANSFORMER IDEAL # 12-123
P_1	LAMP TYPE NE-51
P_L-1	PLUG
S_1	SWITCH SPST NON-LOCKING
S_2	SWITCH SPDT
E_1&E_2	ELECTRODES
F_1	3 AG

FIGURE 17

DATE: May 13, 1959
ENGR. A. Cicerchy

DEARBORN ELECTRONIC LABORATORIES, INC.
P.O. Box 3431
Orlando, Florida

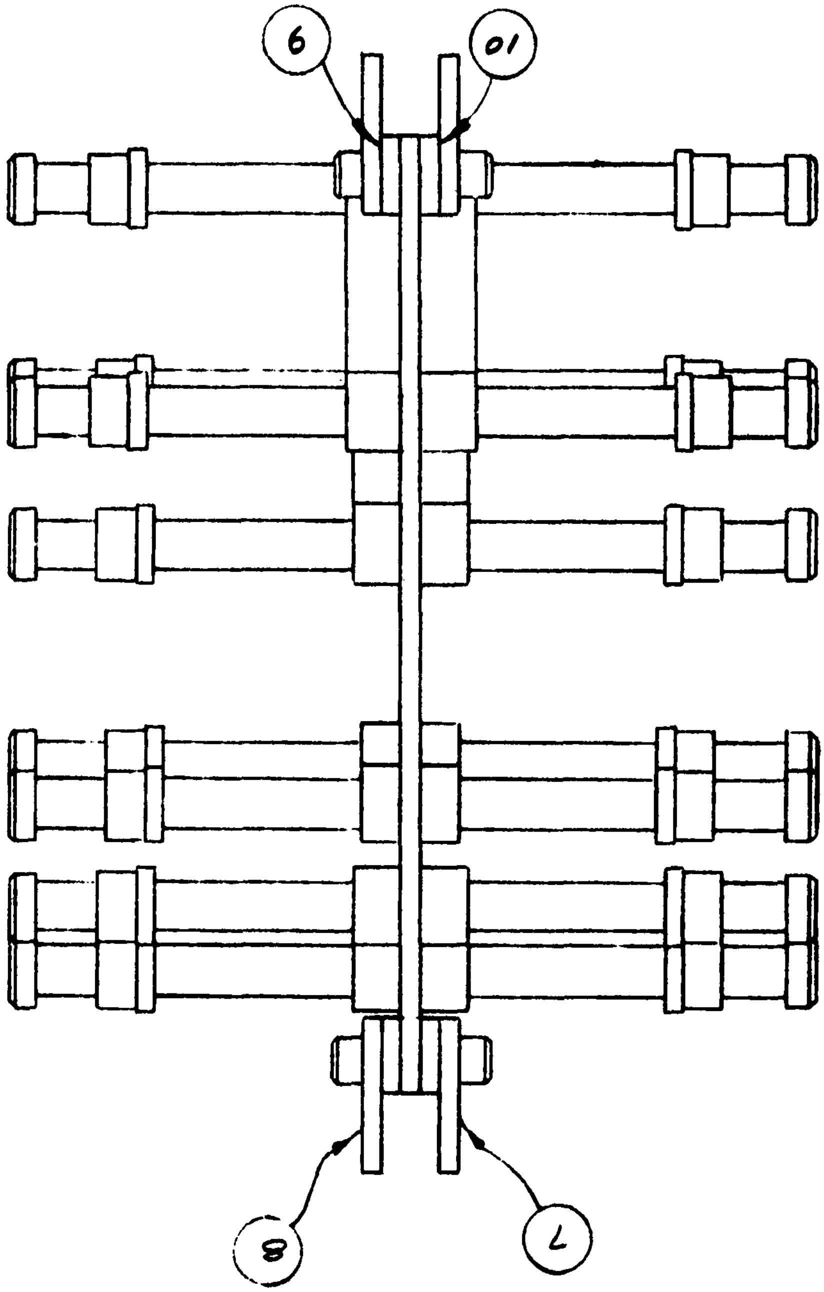


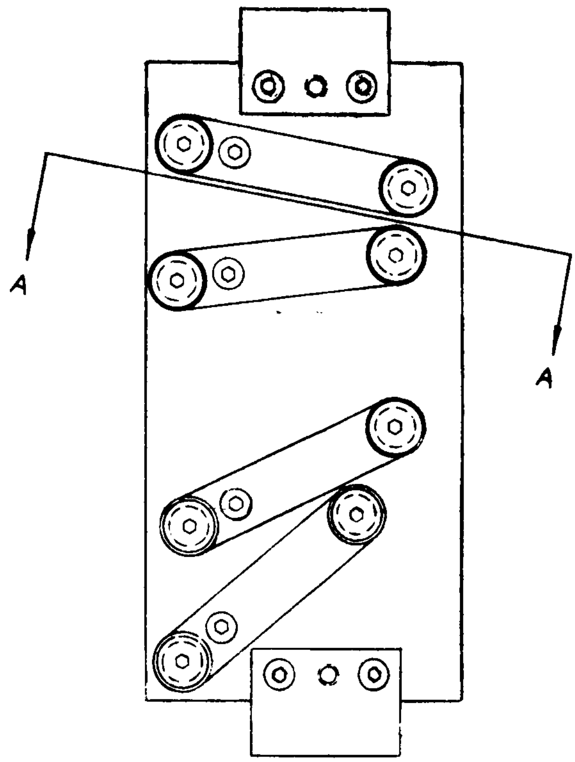
FIGURE # 18

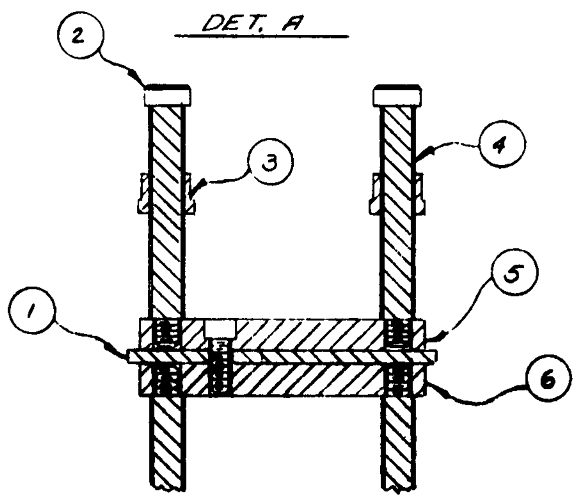
SCALE: FULL

DEARBORN ELECTRONIC LABORATORIES			
DRAWN BY	DATE	APPROVED	DATE
G. Statin	8-15-59		8-15-59

TITLE:

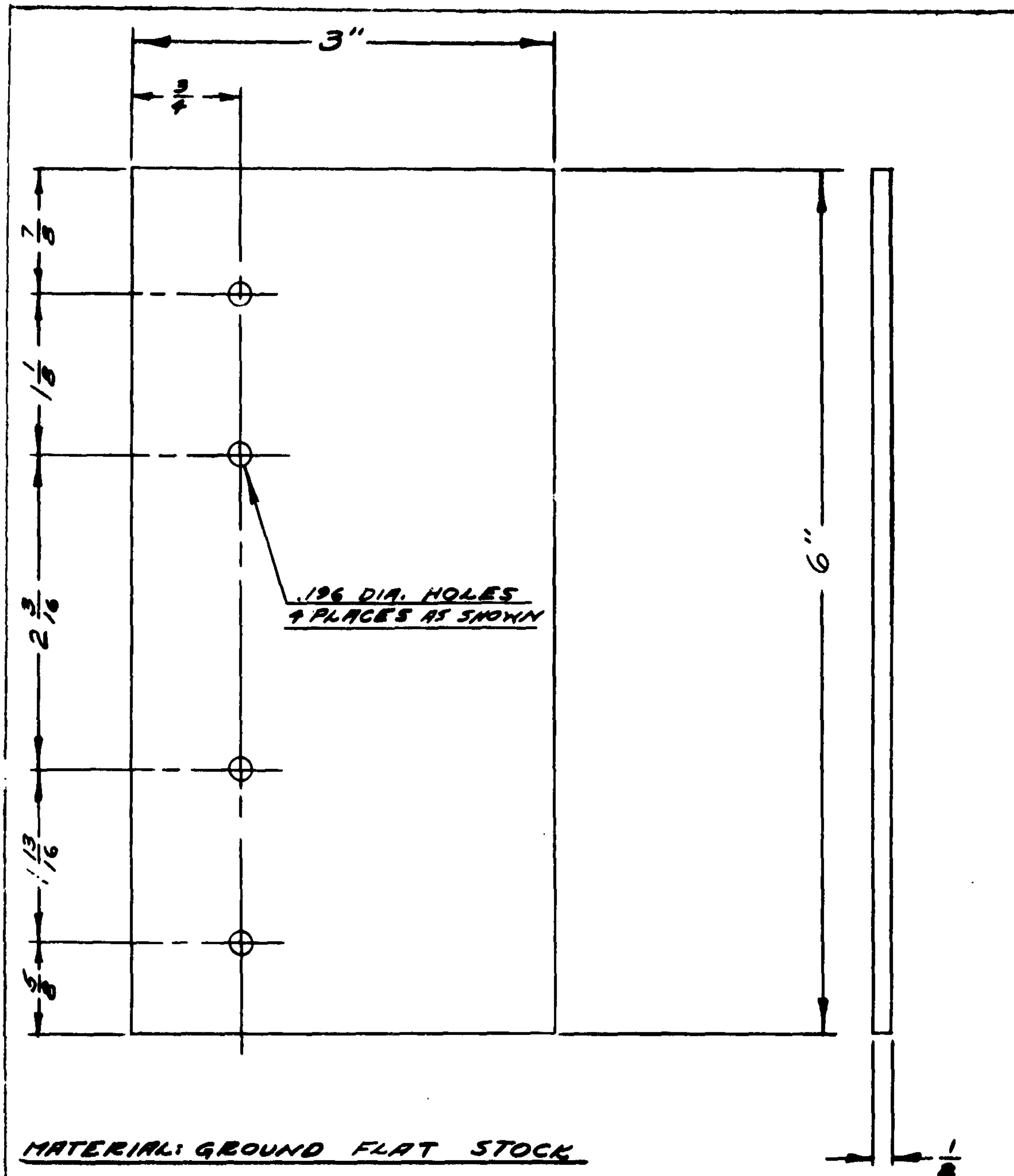
GUIDANCE SYSTEM





DEARBORN ELECTRONIC
LABORATORIES, INC.

FIGURE 18A



MATERIAL: GROUND FLAT STOCK

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DET. #1

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

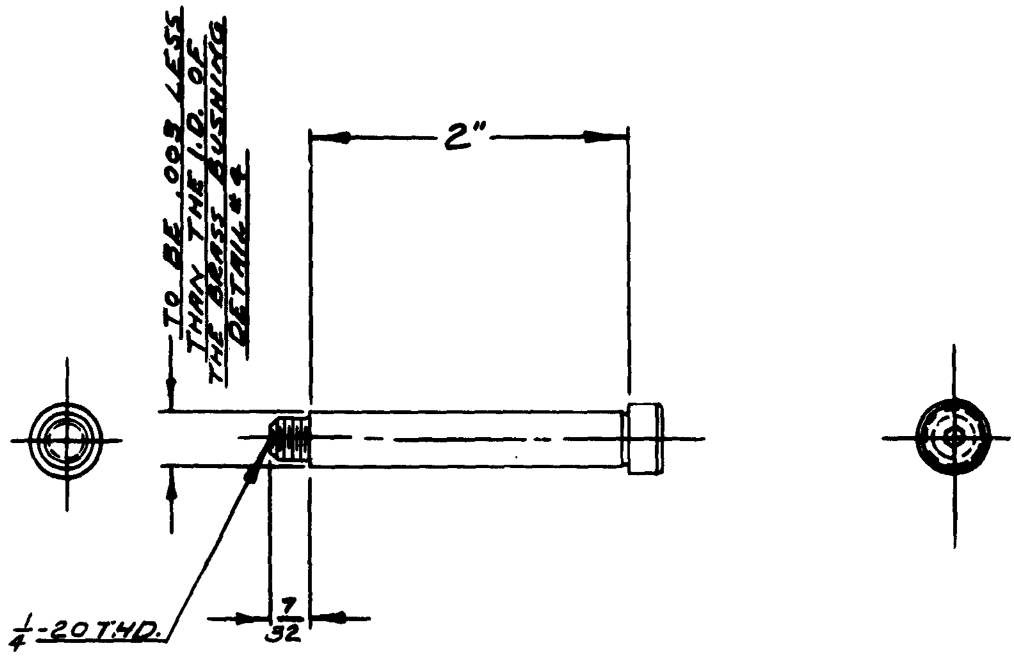
NO.

TITLE MOUNTING PLATE

DRAWN	DATE	ISSUE
H. L.	8-17-57	
APPROVED	DATE	DESIGNER

Form Dea 20

FIGURE 19



STANDARD ALLEN SHOULDER SCREW
5/16 X 2" SHOULDER 1/4-20 THD.
FINISHED AS SHOWN

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DET. #2

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

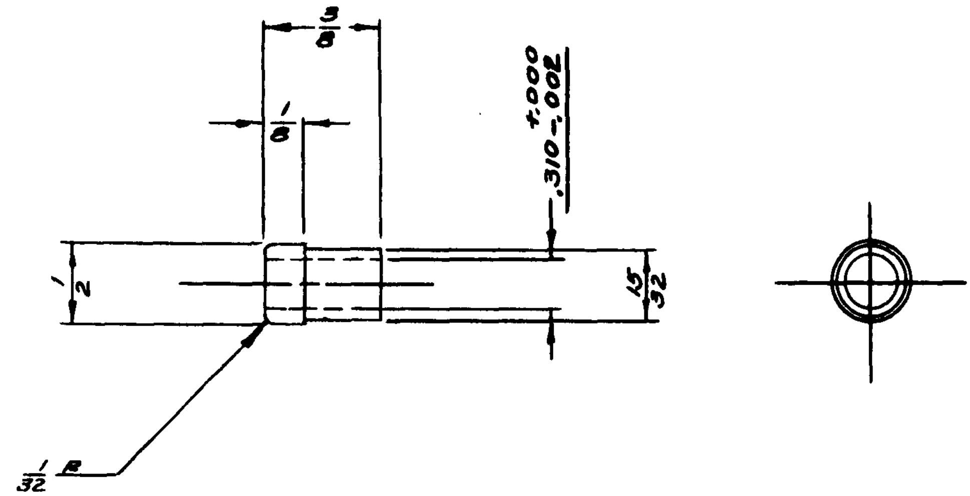
NO.

TITLE SPINDLE

DRAWN H.S.	DATE 8-16-57	ISSUE
APPROVED	DATE	DESIGNER

FIGURE 20

Form Dea 20



MATERIAL: TEFLON

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

SCALE 2"=1" DET. #3

DATE	LOC.	REVISION	DEARBORN ELECTRONIC LABORATORIES			NO.
			TITLE TEFLON BUSHING			
			DRAWN	DATE 2-16-57	ISSUE	
			APPROVED	DATE	DESIGNER	

Form Dea 20

FIGURE 21

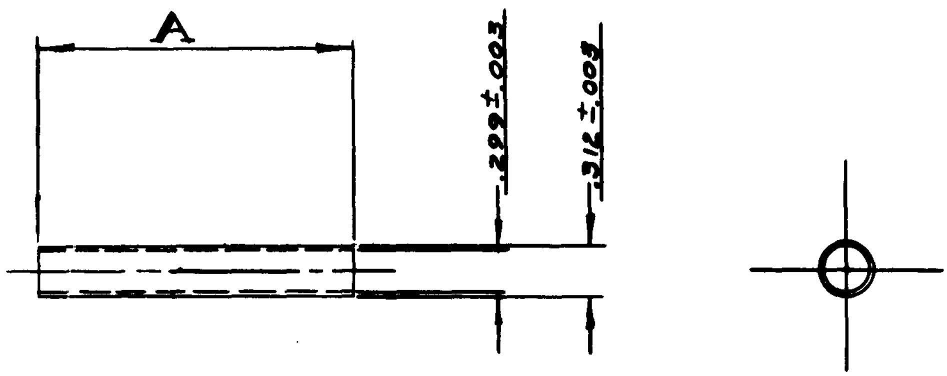


FIGURE 22

NOTE: DIM."A" TO BE APPROX. .002 LESS THAN THE LENGTH OF DETAIL #2

MATERIAL: HARD BRASS

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DET. #4

DATE	LOC.	REVISION

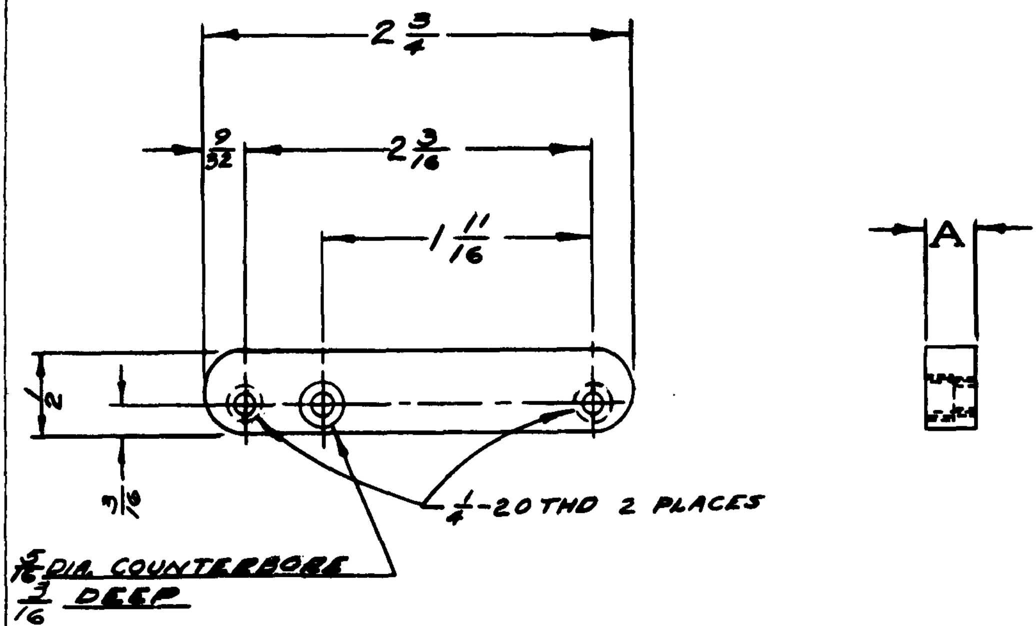
DEARBORN ELECTRONIC LABORATORIES

NO.

TITLE BRASS BUSHING

DRAWN H.S.	DATE 8-19-57	ISSUE
APPROVED	DATE	DESIGNER

Form Dea 20



POSITION	"A" DIM.
1	13/64
2	1/4
3	19/64
4	11/32

MATERIAL: GROUND STOCK

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DET. #5

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

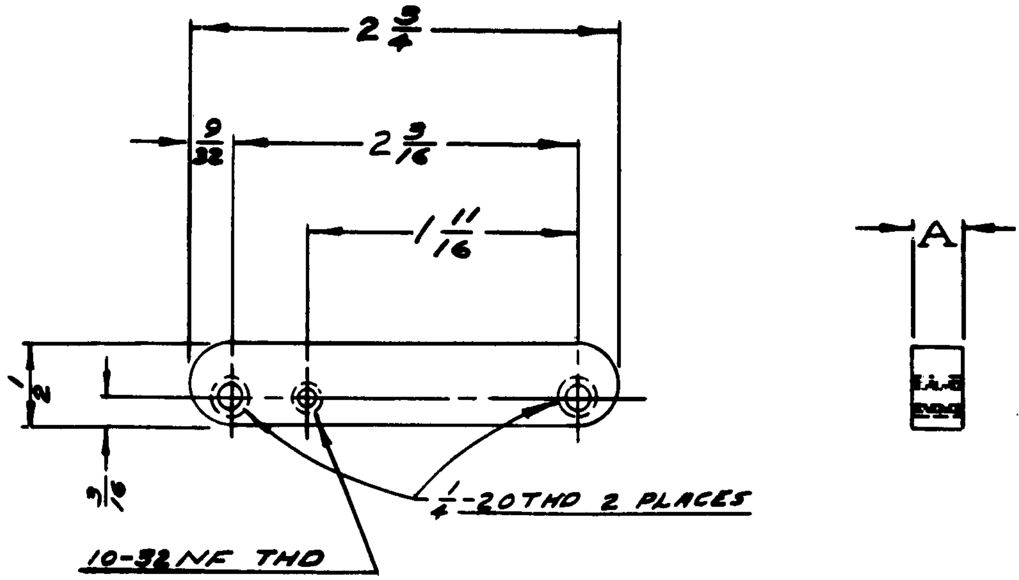
NO.

TITLE

DRAWN	DATE 7-17-59	ISSUE
APPROVED	DATE	DESIGNER

Form Dea 20

FIGURE 23



POSITION	"A" DIM.
1	19/64
2	1/4
3	19/64
4	11/32

MATERIAL: GROUND STOCK

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DET. #6

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

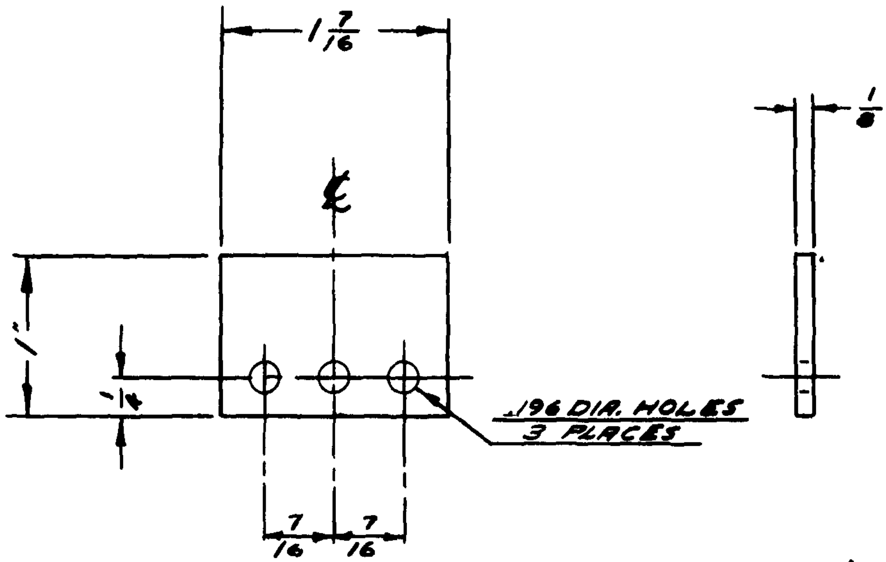
NO.

TITLE

DRAWN H. J.	DATE 8-17-59	ISSUE
APPROVED	DATE	DESIGNER

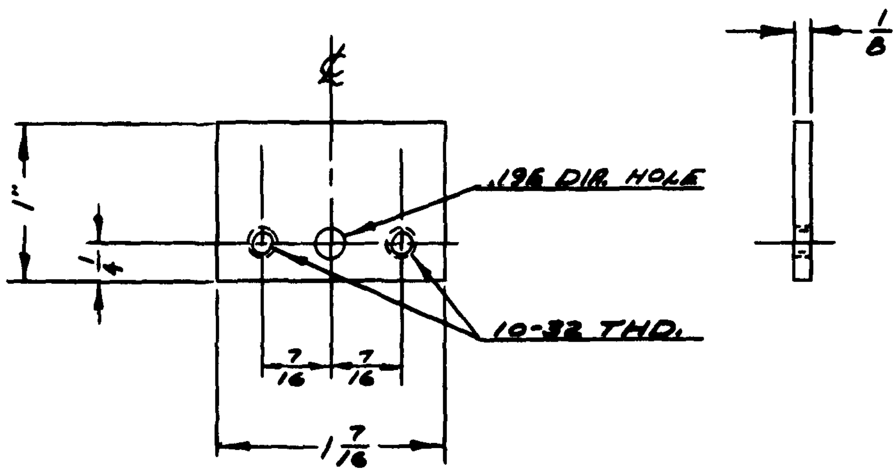
FIGURE 24

Form Dea 20



DET #7

FIGURE 25



MATERIAL: GROUND STOCK

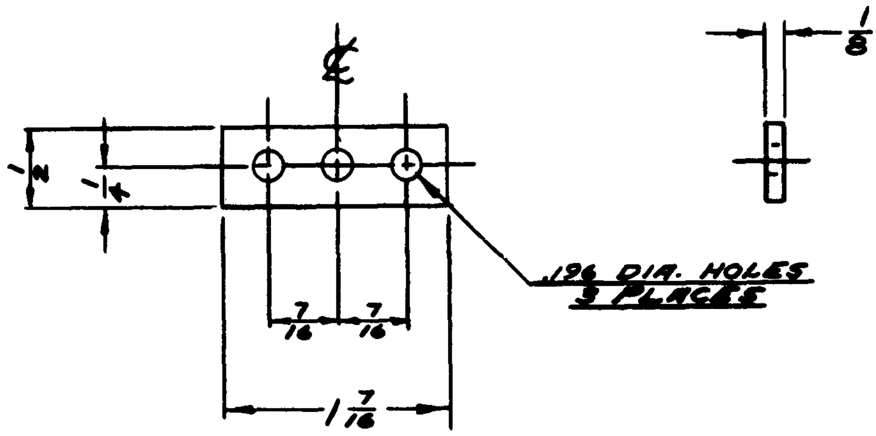
NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DET. #8

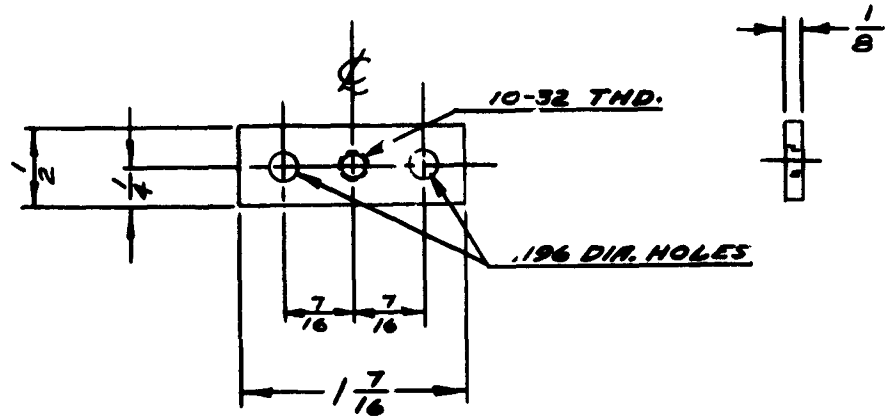
DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES			NO.
TITLE			
DRAWN H.L.	DATE 8-17-59	ISSUE	
APPROVED	DATE	DESIGNER	

Form Dea 20



DET. #9



MATERIAL: GROUND STOCK

NOTE: THE ITEMS LISTED ON THIS DRAWING ARE SUBJECT TO INCOMING INSPECTION BASED ON MIL-STD-105A SAMPLING PLAN.

DET. #10

DATE	LOC.	REVISION

DEARBORN ELECTRONIC LABORATORIES

TITLE

DRAWN	DATE	ISSUE
APPROVED	DATE	DESIGNER

NO.

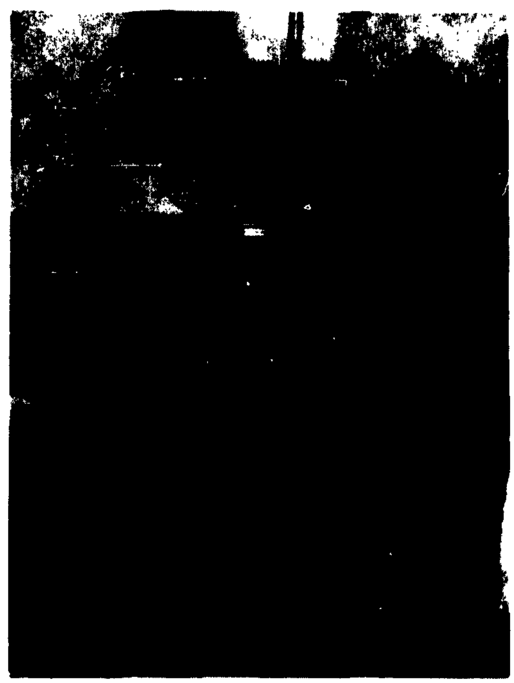
FIGURE 26

Form Dea 20

WINDING MACHINE

WINDING HEAD

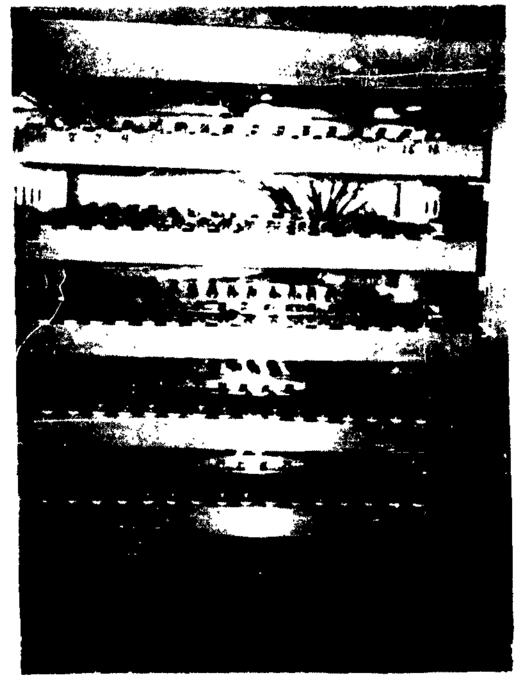
MANDREL AND CUTTING BLADE



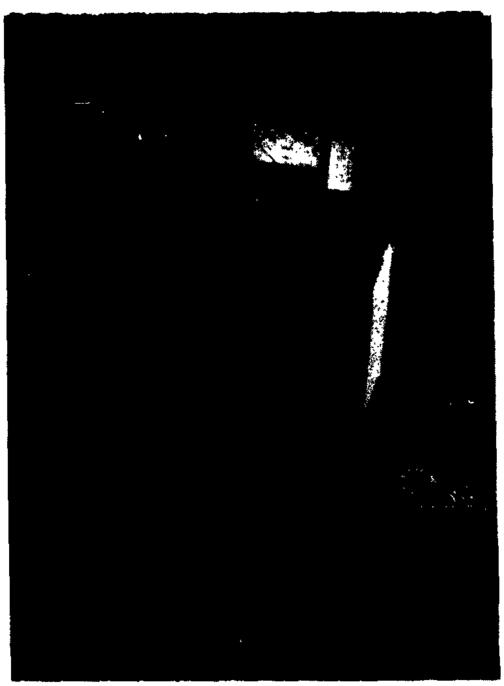
TENSION SPOOL

FIGURE 27

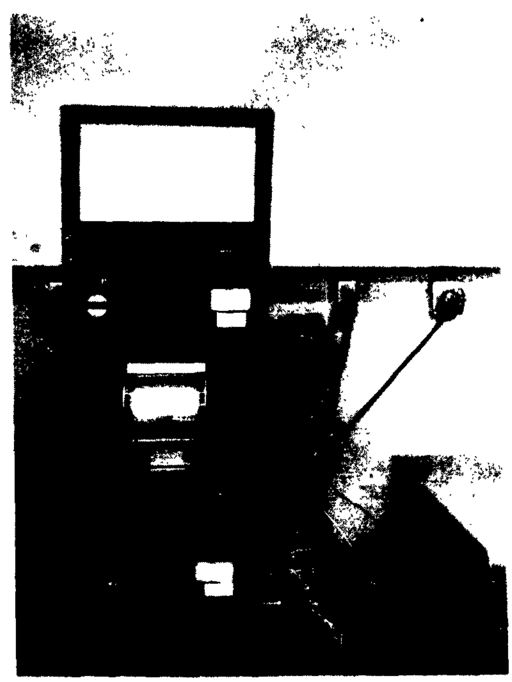
RESISTANCE SOLDERING



LIFE TEST RACKS



CURRENT LIMITING RESISTORS



COUNTING CIRCUITS

FIGURE 28

DEARBORN ELECTRONIC LABORATORIES, INC.

Report No. 462-21R-000 Orlando, Florida Date 13 February 196

Test Data Exhibit WCLK-58-1 Page 1 of 1

Dearborn Type No. MTF102J1 Capacity .001 Voltage 100 Tolerance ± 5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	Before Life Test				After Life Test				Before Life Test at 200°C		
	1000 Cycles		IR Megohms	IR Megohms	____ Cycles			IR Megohms	Cap	DF	IR Megohms
	Cap MFD	DF %	+25°C	°C	Cap. MFD	DF %	Cap. CHG.				
REQ'D	.001 ± 5%	≤ .5	≥ 5000	$\geq 1 \times 10^7$					NR[1]	NR[1]	≥ 500
1	.001083	.02		$> 1 \times 10^7$					.000996	.06	18×10^3
2	.001002	.02		$> 1 \times 10^7$					.000976	.05	16×10^3
3	.000988	.025		$> 1 \times 10^7$					.000976	.03	15×10^3
4	.001020	.02		$> 1 \times 10^7$					.001040	.07	30×10^3
5	.000981	.03		$> 1 \times 10^7$					.000965	.07	7.2×10^3
6	.001037	.00		$> 1 \times 10^7$					.001250	.05	15×10^3
7	.001037	.015		$> 1 \times 10^7$					.001120	.09	12×10^3
8	.001039	.045		$> 1 \times 10^7$					.001220	.05	14×10^3
9	.001036	.005		$> 1 \times 10^7$					.001270	.07	5×10^3
10	.001020	.01		$> 1 \times 10^7$					.001040	.07	14×10^3
11	.001002	.01		$> 1 \times 10^7$					.000976	.06	12×10^3
12	.001043	.00		$> 1 \times 10^7$					.001200	.20	12×10^3
13	.001009	.01		$> 1 \times 10^7$					.000991	1.2	12×10^3
14	.001032	.02		$> 1 \times 10^7$					.001150	.12	11×10^3
15	.000974	.05		$> 1 \times 10^7$					.000961	.25	14×10^3
16	.001023	.08		$> 1 \times 10^7$					.001030	.09	12×10^3
17	.000998	.005		$> 1 \times 10^7$					.000989	.09	11×10^3
18	.000977	.01		$> 1 \times 10^7$					.000964	.08	14×10^3
19	.000992	.025		$> 1 \times 10^7$					.000970	.05	11×10^3
20	.001030	.005		$> 1 \times 10^7$					.001110	.14	9.5×10^3
21	.000954	.02		$> 1 \times 10^7$					.000942	.07	10×10^3
22	.001009	.02		$> 1 \times 10^7$					.000987	.09	5×10^3
23	.001012	.22		$> 1 \times 10^7$					.000935	.24	16×10^3
24	.001023	.05		$> 1 \times 10^7$					.000984	.08	10×10^3

[1] No requirement. Data for information purposes only.

EXHIBIT 1

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-41R-000 Date 4-2-62

Test Data Exhibit WC'K58-1 Page 1 of 1

Dearborn Type No. MTF10231 Capacity .001uF Voltage 100VDC Tolerance ±5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	AFTER LIFE TEST +200°C				AFTER LIFE TEST +25°C				
	1000 cycles CAP MFD	D.F.%	IR MEGOHMS +25°C	IR MEGOHMS +200°C	1000 cycles CAP. MFD.	D.F.%	CAP. CHG.	IR MEGOHMS	
REQ.	NR[1]	NR[1]		≥500	.001	≤.5	≤10%	≥5000	
1.	.000990	.05		20×10^3	.001065	.01	1.66	$>1\times10^5$	
2.	.000972	.06		15×10^3	.000993	.02	.90	$>1\times10^5$	
3.	.000970	.03		15×10^3	.000985	.01	.30	$>1\times10^5$	
4.	.001037	.05		15×10^3	.001012	.04	.78	$>1\times10^5$	
5.	.000950	1.02		8×10^3	.000985	.01	.41	$>1\times10^5$	
6.	.001005	.05		15×10^3	.001030	.01	.68	$>1\times10^5$	
7.	.001018	.01		10×10^3	.001025	.02	1.16	$>1\times10^5$	
8.	.001030	.08		12×10^3	.001032	.03	.67	$>1\times10^5$	
9.	.001020	.07		8×10^3	.001032	.01	.40	$>1\times10^5$	
10.	.001004	.05		15×10^3	.001015	.01	.49	$>1\times10^5$	
11.	.00970	.03		12×10^3	.000995	.01	.70	$>1\times10^5$	
12.	.001012	.25		12×10^3	.001040	.01	.29	$>1\times10^5$	
13.	.000985	.15		10×10^3	.001001	.01	.79	$>1\times10^5$	
14.	.001015	.12		11×10^3	.001018	.01	1.36	$>1\times10^5$	
15.	.000958	.22		11×10^3	.000975	.03	.10	$>1\times10^5$	
16.	.001032	.07		11×10^3	.001040	.08	1.66	$>1\times10^5$	
17.	.000985	.06		12×10^3	.001000	.02	.20	$>1\times10^5$	
18.	.000962	.07		10×10^3	.000980	.01	.31	$>1\times10^5$	
19	.000975	.05		14×10^3	.000990	.02	.20	$>1\times10^5$	
20.	.001010	.12		9×10^3	.001027	.01	.29	$>1\times10^5$	
21.	.000940	.05		11×10^3	.000950	.04	.42	$>1\times10^5$	
22.	.000990	.11		6×10^3	.001001	.03	.79	$>1\times10^5$	
23.	.000950	.20		4×10^3	.000990	.01	2.17	$>1\times10^5$	
24.	.000985	.06		10×10^3	.001015	.03	.78	$>1\times10^5$	

[1]No requirement. Data for information purposes only.
The above tests indicate that the capacitors meet the specification requirements in all respects.

EXHIBIT 2

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-21R-006 Date 15 February 1962

Test Data Exhibit WCLK58-1 Page 1 of 1

Dearborn Type No. MTF103J10 Capacity .01μF Voltage 1000VDC Tolerance ±5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	BEFORE LIFE TEST				AFTER LIFE TEST				BEFORE LIFE TEST AT 200°C		
	1000 cycles CAP. MFD.	DF.%	IR. MEGOHMS +25°C		1000 cycles CAP. MFD	DF%	CAP CHG.	IR MEGOHMS	CAP. MFD.	D.F.%	IR MEGOHMS
REQD.	.01 ±5%	≤.5%	≥5000						.01	NR[1]	≥500
1	.00987	.03	$>100 \times 10^5$						.00957	.04	1×10^5
2.	.01003	.03	$>100 \times 10^5$						.00970	.04	25×10^3
3.	.00951	.07	$>100 \times 10^5$						.00924	.05	20×10^4
4.	.00968	.03	500×10^3						.00938	.01	4.5×10^4
5.	.00977	.04	500×10^3						.00952	.02	7.8×10^4
6.	.01024	.05	500×10^3						.00999	.11	6.5×10^4
7.	.01019	.02	500×10^3						.00990	<.01	3.2×10^4
8.	.00995	.03	$>100 \times 10^5$						.00967	.04	12×10^3
9	.00974	.03	$>100 \times 10^5$						.00947	.25	10.5×10^3
10.	.00959	.03	$>100 \times 10^5$						.00897	.39	12×10^3
11.	.00958	.03	$>100 \times 10^5$						.00925	.04	16×10^3
12.	.00976	.05	$>100 \times 10^5$						.00947	.25	5×10^4
13.	.00958	.04	500×10^3						.00929	.02	20×10^4
14.	.00972	.02	500×10^3						.00944	.05	20×10^4
15.	.00998	.02	500×10^3						.00974	<.01	5.2×10^4
16.	.00983	.03	$>100 \times 10^5$						.00948	.04	19×10^3
17.	.01015	.03	500×10^3						.00869	1.05	4.5×10^4
18.	.00983	.03	$>100 \times 10^5$						.00957	.03	14×10^5
19.	.00983	.03	$>100 \times 10^5$						.00953	.04	13×10^3
20.	.00958	.03	$>100 \times 10^5$						.00771	.33	14.5×10^3
21.	.00951	.03	$>100 \times 10^5$						.00924	.04	15×10^3
22.	.00998	.01	$>100 \times 10^5$						.00966	.53	23×10^3
23.	.00991	.03	$>100 \times 10^5$						.00963	.03	22×10^3
24.	.00975	.05	$>100 \times 10^5$						.00943	.10	5×10^6

[1] No requirement. Data for information purposes only.

EXHIBIT 3

DEARBORN ELECTRONIC LABORATORIES, INC.

Report No. 462-47R-000 Orlando, Florida Date 4-2-62

Test Data Exhibit WALKER-1 Page 1 of 1

Dearborn Type No. MTF103J10 Capacity .01 Voltage 1000 VDC Tolerance ±5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	AFTER LIFE TEST 1000 cycles				AFTER LIFE TEST 1000 cycles				
	CAP MFD	DF%	IR MEGOHMS 25°C	IR MEGOHMS 200 °C	CAP MFD	DF%	CAP. CHG	IR MEGOHMS	REMARKS
	NR [1]	NR [1]		≥ 500	.01	≤.5	≤10%	≥ 5000	
1.	.00942	.04		32×10^3	.00953	.03	3.44	$> 1 \times 10^7$	
2.	.00979	.05		19×10^3	.01009	.02	.59	$> 1 \times 10^7$	
3	.00931	.05		20×10^3	.00942	.03	.94	$> 1 \times 10^7$	
4	.00921	.03		16×10^3	.00956	.04	1.23	$> 1 \times 10^7$	
5	.00943	.02		19×10^3	.00947	.05	3.07	$> 1 \times 10^7$	
6.	.00984	.11		23×10^3	.01033	.02	.87	$> 1 \times 10^7$	
7.	.00975	.21		20×10^3	.01019	.02	0	$> 1 \times 10^7$	
8.	.00964	.04		17×10^3	.01003	.04	.80	$> 1 \times 10^7$	
9.	.00931	.33		15×10^3	.00967	.04	.71	$> 1 \times 10^7$	
10.	.00965	.51		10×10^3	.00980	.03	2.18	$> 1 \times 10^7$	
11.	.00922	.25		12×10^3	.00964	.05	.62	$> 1 \times 10^7$	
12.	.00943	.04		21×10^3	.00969	.05	.71	$> 1 \times 10^7$	
13.	.00919	.05		23×10^3	.00966	.05	.83	$> 1 \times 10^7$	
14	.00987	.04		25×10^3	.01004	.03	3.29	$> 1 \times 10^7$	
15.	.00996	.39		23×10^3	.01015	.02	1.70	$> 1 \times 10^7$	
16	.00954	.41		20×10^3	.00977	.02	.61	$> 1 \times 10^7$	
17.	.00989	.16		14×10^3	.01025	.03	.98	$> 1 \times 10^7$	
18	.00938	.19		25×10^3	.00968	.04	1.52	$> 1 \times 10^7$	
19.	.00963	.03		16×10^3	.00970	.03	1.32	$> 1 \times 10^7$	
20	.00935	.06		7×10^3	.00963	.05	.52	$> 1 \times 10^7$	
21.	.00906	.05		15×10^3	.00939	.02	1.26	$> 1 \times 10^7$	
22.	.00979	.04		9×10^3	.01007	.02	.90	$> 1 \times 10^7$	
23	.00964	.02		13×10^3	.00980	.03	1.10	$> 1 \times 10^7$	
24.	.00975	.02		5×10^3	.00991	.04	1.64	$> 1 \times 10^7$	

1 No requirement. Data for information purposes only.

The above tests indicate that the capacitors meet the specification requirements in all respects.

EXHIBIT 4

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-21R-000
Date 13 February 1962
Test Data Exhibit WCLK58-1
Page 1 of 1
Dearborn Type No. MTF473J10 Capacity .047 Voltage 1000 VDC Tolerance ± 5%
Life Test Voltage 140% Temperature 200 °C Hours 1000

	BEFORE LIFE TEST				AFTER LIFE TEST				BEFORE LIFE TEST AT 200 °C		
	1000 cycles CAP. MFD	D.F.%	I R MEGOHMS +25 °C	I R MEGOHMS	——— cycles CAP. MFD	D.F.%	CAP. CHG.	I R MEGOHMS	CAP. MFD	D.F.%	I R MEGOHMS
REQD.	.047 ± 5%	< .5%	≥ 5000						.047	NR[1]	≥ 500
1	.04550	.02	> 1 X 10^7						.04383	.02	5 X 10^5
2	.04612	.02	> 1 X 10^7						.04425	.02	45 X 10^3
3	.04676	.02	> 1 X 10^7						.04505	.03	8 X 10^3
4	.04662	.02	> 1 X 10^7						.04545	.04	25 X 10^3
5	.04820	.39	> 1 X 10^7						.04631	.27	55 X 10^3
6	.04801	.14	> 1 X 10^7						.04640	.46	26 X 10^3
7	.04699	.03	> 1 X 10^7						.04524	.03	42 X 10^3
8	.04677	.02	> 1 X 10^7						.04522	.03	20 X 10^4
9	.04761	.02	> 1 X 10^7						.04589	.03	12 X 10^3
10	.04697	.02	> 1 X 10^7						.04523	.03	12 X 10^4
11	.04745	.03	> 1 X 10^7						.04562	.05	12 X 10^3
12	.04686	.02	> 1 X 10^7						.04512	.02	14 X 10^3
13	.04684	.02	> 1 X 10^7						.04516	.04	11 X 10^4
14	.04715	.02	> 1 X 10^7						.04553	.04	75 X 10^3
15	.04717	.02	> 1 X 10^7						.04546	.03	18 X 10^4
16	.04570	.02	> 1 X 10^7						.04403	.04	1 X 10^6
17	.04670	.02	> 1 X 10^7						.04505	.02	12 X 10^4
18	.04669	.02	> 1 X 10^7						.04489	.03	5 X 10^5
19	.04634	.08	> 1 X 10^7						.04445	.12	12 X 10^4
20	.04750	.02	> 1 X 10^7						.04570	.23	6 X 10^4
21	.04760	.02	> 1 X 10^7						.04597	.04	40 X 10^4
22	.04679	.02	> 1 X 10^7						.04515	.04	18 X 10^4
23	.04636	.02	> 1 X 10^7						.04443	.03	30 X 10^4
24	.04650	.03	> 1 X 10^7						.04515	.04	25 X 10^4

1 No requirement. Data for information purposes only.

EXHIBIT 5

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-48R.000 Date 4-2-62
Test Data Exhibit WCKL58-1 Page 1 of 1
Dearborn Type No. MTF473J10 Capacity .047 Voltage 1000 VDC Tolerance ±5%
Life Test Voltage 140 % Temperature 200 °C Hours 1000

	AFTER LIFE TEST + 200°C				AFTER LIFE TEST + 25°C				
	1000 cycles		IR MEGOHMS	IR MEGOHMS	1000 cycles			IR MEGOHMS	
	CAP MFD	DF%	+25°C	200°C	CAP MFD	DF%	CAP CHG	MEGOHMS	REMARKS
	1	1		≥500	.047 ±5%	2.5	±10%	≥5000	
1.	.04387	.03		12×10^3	.04641	.05	2.56	$>1 \times 10^7$	
2.	.04520	.04		8×10^3	.04772	.43	3.47	$>1 \times 10^7$	
3.	.04517	.02		40×10^3	.04718	.04	.90	$>1 \times 10^7$	
4	.04523	.05		35×10^3	.04676	.02	.30	$>1 \times 10^7$	
5.	.04638	.05		20×10^3	.04648	.24	3.59	$>1 \times 10^7$	
6.	.04629	.06		40×10^3	.04674	.01	2.65	$>1 \times 10^7$	
7.	.04533	.03		26×10^3	.04656	.02	.92	$>1 \times 10^7$	
8.	.04516	.03		25×10^3	.04667	.48	.21	$>1 \times 10^7$	
9	.04567	.02		8×10^3	.04672	.46	1.87	$>1 \times 10^7$	
10.	.04528	.12		12×10^3	.04685	.10	.26	$>1 \times 10^7$	
11	.04575	.30		12×10^3	.04666	.03	1.66	$>1 \times 10^7$	
12.	.04501	.05		11×10^3	.04776	.49	1.92	$>1 \times 10^7$	
13.	.04529	.06		62×10^3	.04632	.02	1.11	$>1 \times 10^7$	
14	.04517	.04		12×10^3	.04628	.47	1.85	$>1 \times 10^7$	
15	.04500	.04		14×10^3	.04508	.01	4.43	$>1 \times 10^7$	
16.	.04522	.03		6×10^3	.04540	.45	.66	$>1 \times 10^7$	
17.	.04495	.02		18×10^3	.04720	.31	1.06	$>1 \times 10^7$	
18.	.04462	.02		30×10^3	.04574	.50	2.03	$>1 \times 10^7$	
19.	.04425	.03		25×10^3	.04596	.18	.82	$>1 \times 10^7$	
20	.04578	.12		6×10^3	.04658	.01	1.94	$>1 \times 10^7$	
21.	.04596	.05		11×10^3	.04748	.04	.25	$>1 \times 10^7$	
22	.04509	.06		26×10^3	.04683	.03	.09	$>1 \times 10^7$	
23.	.04491	.04		30×10^3	.04645	.03	.19	$>1 \times 10^7$	
24.	.04582	.05		25×10^3	.04631	.02	.41	$>1 \times 10^7$	

1 No requirement. Data for information purposes only.
The above tests indicates that the capacitors meet the specification requirements in all respects.

EXHIBIT 6

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-21B-000 Date 13 February 1962

Test Data Exhibit WCLK58-1 Page 1 of 1

Dearborn Type No. MTE104J1 Capacity .1 MFD Voltage 600 VDC Tolerance ±5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	BEFORE LIFE TEST 1000 cycles				AFTER LIFE TEST ___ cycles				BEFORE LIFE TEST AT 200°C		
	CAP. MFD	D.F %	IR MEGOHMS +25°C	IR MEGOHMS	CAP. MFD	D.F %	CAP. CHG.	IR MEGOHMS	CAP. MFD	D.F %	IR MEGOHMS
REQ'D	.1 ±5%	≤.5%	≥5000						NR[1]	NR[1]	≥500
1	.09594	<.01	$>1 \times 10^7$						.09132	.01	65×10^3
2	.10399	<.01	$>1 \times 10^7$						.10002	.02	11×10^4
3	.09666	<.01	$>1 \times 10^7$						.09300	.03	30×10^3
4	.10260	<.01	$>1 \times 10^7$						.09907	.01	22×10^3
5	.09800	<.01	$>1 \times 10^7$						.09290	<.01	10×10^3
6	.09946	<.01	$>1 \times 10^7$						.09495	.01	55×10^3
7	.09581	<.01	$>1 \times 10^7$						.09530	.02	48×10^3
8	.10199	<.01	$>1 \times 10^7$						.09780	.01	10×10^4
9	.09733	<.01	$>1 \times 10^7$						.09357	.02	50×10^4
10	.09692	<.01	$>1 \times 10^7$						.09291	.02	85×10^4
11	.09799	<.01	$>1 \times 10^7$						.09371	.01	12×10^3
12	.09974	<.01	$>1 \times 10^7$						.09490	.01	13×10^3
13	.09782	<.01	$>1 \times 10^7$						.09420	.02	9×10^3
14	.09980	<.01	$>1 \times 10^7$						.09753	.02	12×10^3
15	.09920	<.01	$>1 \times 10^7$						.09470	.01	10×10^3
16	.10158	<.01	$>1 \times 10^7$						.09820	.02	6×10^3
17	.09816	<.01	$>1 \times 10^7$						.09367	.01	70×10^3
18	.10229	<.01	$>1 \times 10^7$						.09810	.20	14×10^3
19	.10093	<.01	$>1 \times 10^7$						.09691	.01	40×10^3
20	.09952	<.01	$>1 \times 10^7$						.09588	.02	24×10^3
21	.09922	<.01	$>1 \times 10^7$						.09472	.01	26×10^3
22	.10070	<.01	$>1 \times 10^7$						.09934	.02	12×10^3
23	.09911	<.01	$>1 \times 10^7$						.09539	.02	9×10^3
24	.09971	<.01	$>1 \times 10^7$						.09562	.02	8×10^3

1 No requirement. Data for information purposes only.

EXHIBIT 7

DEARBORN ELECTRONIC LABORATORIES, INC.
ORLANDO, FLORIDA

Report no. 462-45R-000 Date 4-2-67
Test Data Exhibit WCLK58-1 Page 1 of 1
Dearborn Type No. MTF104J6 Capacity .1uF Voltage 600VDC Tolerance ±5%
Life Test Voltage 140 Temperature 200 °C Hours 1000

	AFTER LIFE TEST +200°C				AFTER LIFE TEST +25°C				
	1000 cycles CAP MFD	DF%	IR MEGOHMS +25°C	IR MEGOHMS 200 °C	1000 cycles CAP MFD	DF%	CAP CHG	IR MEGOHMS	REMARKS
REQD	NR [1]	NR [1]		≥ 500	.1 ±5%	≤.5	≤10%	≥ 5000	
1.	.09130	.04		60×10^3	.09550	<.01	.45	$> 1 \times 10^5$	
2.	.09997	.02		80×10^3	.10322	<.01	.74	$> 1 \times 10^5$	
3.	.09295	.05		27×10^3	.09670	<.01	.04	$> 1 \times 10^5$	
4	.09900	.02		24×10^3	.10195	<.01	.63	$> 1 \times 10^5$	
5	.09281	.02		9×10^3	.09775	<.01	.25	$> 1 \times 10^5$	
6.	.09486	.01		50×10^3	.09970	<.01	.24	$> 1 \times 10^5$	
7.	.09522	.04		47×10^3	.09568	<.01	.13	$> 1 \times 10^5$	
8	.09765	.02		80×10^3	.10107	<.01	.90	$> 1 \times 10^5$	
9	.09352	.03		45×10^3	.09700	<.01	.33	$> 1 \times 10^5$	
10.	.09285	.08		60×10^3	.09680	<.01	.12	$> 1 \times 10^5$	
11.	.09365	.02		15×10^3	.09790	<.01	.09	$> 1 \times 10^5$	
12.	.09478	.01		12×10^3	.09467	<.01	.07	$> 1 \times 10^5$	
13.	.09412	.01		11×10^3	.09765	<.01	.19	$> 1 \times 10^5$	
14.	.09740	.03		10×10^3	.09962	<.01	.18	$> 1 \times 10^5$	
15	.09460	.01		7×10^3	.09903	<.01	.17	$> 1 \times 10^5$	
16	.09811	.06		8×10^3	.10142	<.01	.15	$> 1 \times 10^5$	
17	.09359	.02		20×10^3	.09801	<.01	.15	$> 1 \times 10^5$	
18	.09801	.20		15×10^3	.10200	<.01	.28	$> 1 \times 10^5$	
19	.09680	.03		35×10^3	.10015	<.01	.77	$> 1 \times 10^5$	
20	.09577	.01		20×10^3	.09952	<.01	0	$> 1 \times 10^5$	
21.	.09465	.03		25×10^3	.09910	<.01	.12	$> 1 \times 10^5$	
22.	.09925	.05		10×10^3	.10033	<.01	.36	$> 1 \times 10^5$	
23	.09530	.03		10×10^3	.09902	<.01	.09	$> 1 \times 10^5$	
24.	.09560	.02		5×10^3	.09950	<.01	.21	$> 1 \times 10^5$	

1 No requirement. Data for information purposes only.
The above tests indicate that the capacitors meet the specified requirements in all respects.

EXHIBIT 8

DEARBORN ELECTRONIC LABORATORIES, INC.

Orlando, Florida

Report No. 462-21B-000   Date 13 February [illegible]

Test Data Exhibit WCLK58-1   Page 1 of 1

Dearborn Type No. MTF474J6   Capacity .47 mfd   Voltage 600 VDC   Tolerance ± 5%

Life Test Voltage 140 %   Temperature 200 °C   Hours 1000

	BEFORE LIFE TEST				AFTER LIFE TEST				BEFORE LIFE TEST AT 200°C		
	1000 cycles		IR MEGOHMS	IR MEGOHMS	___ cycles			IR			IR
	CAP. MFD.	DF%	+25°C	___°C	CAP. MFD	D.F.%	CAP. CHG	MEGOHMS	CAP. MFD	DF%	MEGOHMS
	.47 ± 5%	2.5%	≥ 5000						.47	NR[1]	≥ 500
1	.4604	.04	$>1 \times 10^7$						.4364	.07	30×10^3
2	.4755	.05	$>1 \times 10^7$						.4535	.16	7.5×10^3
3	.4814	.09	$>1 \times 10^7$						.4542	.20	20×10^3
4	.4907	.02	$>1 \times 10^7$						.4660	.05	8×10^3
5	.4873	.07	$>1 \times 10^7$						.4664	.48	7.5×10^3
6	.4733	.02	$>1 \times 10^7$						.4608	.76	10×10^4
7	.4715	.04	$>1 \times 10^7$						.4499	.29	14×10^3
8	.4656	.03	$>1 \times 10^7$						.4428	.32	9×10^3
9	.4715	.02	$>1 \times 10^7$						.4494	.08	70×10^3
10	.4737	.09	$>1 \times 10^7$						.4519	.23	2.2×10^3
11	.4696	.02	$>1 \times 10^7$						.4489	.12	50×10^3
12	.4699	.03	$>1 \times 10^7$						.4429	.17	8.5×10^3
13	.4719	.09	$>1 \times 10^7$						.4484	.44	40×10^3
14	.4642	.04	$>1 \times 10^7$						.4385	.11	4×10^3
15	.4680	.02	$>1 \times 10^7$						.4449	.05	4.5×10^3
16	.4791	.03	$>1 \times 10^7$						.4537	.04	9.5×10^3
17	.4816	.03	$>1 \times 10^7$						.4583	.05	8.5×10^3
18	.4831	.08	$>1 \times 10^7$						.4580	.23	7.5×10^3
19	.4761	.03	$>1 \times 10^7$						.4512	.04	5.5×10^3
20	.4849	.03	$>1 \times 10^7$						.4626	.04	32×10^3
21	.4682	.02	$>1 \times 10^7$						.4447	.04	4×10^3
22	.4740	.02	$>1 \times 10^7$						.4515	.04	12×10^3
23	.4818	.02	$>1 \times 10^7$						.4592	.05	14×10^3
24	.4861	.09	$>1 \times 10^7$						.4633	.05	45×10^3

1 No requirement. Data for information purposes only.

EXHIBIT 9

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462 46R.000 Date 4-2-62

Test Data Exhibit WELK 58-1 Page 1 of 1

Dearborn Type No. MTE474J6 Capacity .47 MFD Voltage 600VDC Tolerance ± 5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	AFTER LIFE TEST +200°C 1000 cycles CAP. MFD	D.F.%	I R MEGOHMS +25°C	I R MEGOHMS +200°C	AFTER LIFE TEST +25°C 1000 cycles CAP. MFD	D.F.%	CAP. CHG.	I R MEGOHMS	REMARKS
REQD	NR[1]	NR[1]		≥ 500	.47	≤ .5	≤ 10%	≥ 5000	
1	.4496	.10		20 X 10^3	.4610	.09	.13	> 1 X 10^7	
2	.4624	.18		8 X 10^3	.4748	.07	.14	> 1 X 10^7	
3	.4687	.23		20 X 10^3	.4802	.03	.24	> 1 X 10^7	
4	.4774	.48		14 X 10^3	.4919	.04	.24	> 1 X 10^7	
5	.4691	.29		9 X 10^3	.4862	.02	.22	> 1 X 10^7	
6	.4701	.12		40 X 10^3	.4739	.04	.12	> 1 X 10^7	
7	.4624	.17		9.5 X 10^3	.4719	.03	.08	> 1 X 10^7	
8	.4509	.11		3.2 X 10^3	.4625	.03	.66	> 1 X 10^7	
9	.4692	.44		4 X 10^3	.4731	.09	.33	> 1 X 10^7	
10	.4687	.23		14 X 10^3	.4723	.08	.29	> 1 X 10^7	
11	.4565	.04		9 X 10^3	.4688	.02	.17	> 1 X 10^7	
12	.4620	.04		70 X 10^3	.4707	.03	.17	> 1 X 10^7	
13	.4603	.05		8 X 10^3	.4734	.03	.31	> 1 X 10^7	
14	.4467	.16		3.7 X 10^3	.4598	.09	.94	> 1 X 10^7	
15	.4586	.07		7.8 X 10^3	.4697	.03	.36	> 1 X 10^7	
16	.4779	.32		6 X 10^3	.4817	.04	.54	> 1 X 10^7	
17	.4750	.04		22 X 10^3	.4835	.02	.39	> 1 X 10^7	
18	.4724	.23		14 X 10^3	.4862	.03	.64	> 1 X 10^7	
19	.4514	.05		43 X 10^3	.4786	.02	.53	> 1 X 10^7	
20	.4605	.32		4 X 10^3	.4835	.03	.29	> 1 X 10^7	
21	.4522	.12		8 X 10^3	.4669	.07	.28	> 1 X 10^7	
22	.4616	.17		16 X 10^3	.4754	.06	.30	> 1 X 10^7	
23	.4775	.05		20 X 10^3	.4823	.04	.10	> 1 X 10^7	
24	.4724	.04		8 X 10^3	.4890	.02	.60	> 1 X 10^7	

1 No requirement. Data for information purposes only.
The above tests indicate that these capacitors meet the specification requirements in all respects.

EXHIBIT 10

DEA-74

DEARBORN ELECTRONIC LABORATORIES, INC.

Report No. 462-21R-000 Orlando, Florida Date 13 February 1962

Test Data Exhibit WCLK58-1 Page 1 of 1

Dearborn Type No. MTF105J4 Capacity 1.0 MFD Voltage 400 VDC Tolerance ±5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	BEFORE LIFE TEST				AFTER LIFE TEST				BEFORE LIFE TEST AT 200°		
	1000 cycles				____ cycles						
	CAP. MFD	D.F. %	I R MEGOHMS +25°C	I R MEGOHMS	CAP MFD	D.F %	CAP. CHG.	I R MEGOHMS	CAP MFD	D.F %	I R MEGOHMS
REQD	1.0 ±5%	≤.5%	≥5000						NR[1]	NR[1]	≥500
1	1.0311	.25	$>1 \times 10^7$						.9966	.47	7.5×10^3
2	1.0426	.36	$>1 \times 10^7$						.9852	.44	55×10^3
3	1.0466	.24	$>1 \times 10^7$						.9845	.40	3.7×10^3
4	1.0380	.19	$>1 \times 10^7$						.9990	.40	65×10^3
5	1.0450	.17	$>1 \times 10^7$						.9849	.38	3.8×10^3
6	1.0362	.14	$>1 \times 10^7$						.9777	.32	5.7×10^3
7	1.0256	.31	$>1 \times 10^7$						.9690	.44	9.0×10^3
8	1.0186	.11	$>1 \times 10^7$						.9578	.28	5.0×10^3
9	1.0303	.25	$>1 \times 10^7$						.9693	.46	5.2×10^3
10	1.0312	.35	$>1 \times 10^7$						.9683	.30	10.0×10^3
11	1.0416	.31	$>1 \times 10^7$						.9895	.32	4.0×10^3
12	1.0320	.13	$>1 \times 10^7$						.9861	.39	1.0×10^3
13	1.0410	.30	$>1 \times 10^7$						1.0175	.49	20×10^3
14	1.0418	.26	$>1 \times 10^7$						.9880	.37	22×10^3
15	1.0315	.28	$>1 \times 10^7$						.9801	.13	3.0×10^3
16	1.0193	.16	$>1 \times 10^7$						.9747	.42	9.5×10^3
17	1.0426	.22	$>1 \times 10^7$						.9802	.23	50×10^3
18	1.0375	.15	$>1 \times 10^7$						.9862	.37	75×10^3
19	1.0413	.27	$>1 \times 10^7$						.9565	.34	40×10^3
20	1.0460	.28	$>1 \times 10^7$						.9399	.18	3.2×10^3
21	1.0389	.24	$>1 \times 10^7$						.9948	.47	7.0×10^3
22	1.0378	.21	$>1 \times 10^7$						.9525	.19	3.0×10^3
23	1.0447	.18	$>1 \times 10^7$						.9573	.32	2.3×10^3
24	1.0436	.19	$>1 \times 10^7$						.9611	.46	3.0×10^3

1 No requirement. Data for information purposes only.

EXHIBIT 11

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-44R-000 Date 4-2-62

Test Data Exhibit WCLK58-1 Page 1 of 1

Dearborn Type No. MIF105J4 Capacitance 1.0uF Voltage 400VDC Tolerance ±5%

Life Test Voltage 140% Temperature 200°C Hours 1000

	AFTER LIFE TEST +200°C				AFTER LIFE TEST +25°C				
	1000 cycles CAP. MFD.	D.F.%		IR MEGOHMS 200°C	1000 cycles CAP. MFD.	D.F.%	CAP C% G.	IR MEGOHMS	
REQ.	NR[1]	NR[1]		≥ 500	1.0 ±5%	≥ .5	≥ 10	≥ 5000	
1.	.9960	.49		6.0 x 10³	1.0153	.31	1.53	> 1 x 10⁵	
2.	.9843	.50		5.2 x 10³	1.0127	.25	2.86	> 1 x 10⁵	
3.	.9832	.41		4.0 x 10³	1.0225	.25	2.30	> 1 x 10⁵	
4.	.9976	.41		5.7 x 10³	1.0105	.10	2.64	> 1 x 10⁵	
5.	.9840	.40		3.2 x 10³	1.0101	.20	3.33	> 1 x 10⁵	
6.	.9761	.40		5.3 x 10³	1.0050	.18	3.01	> 1 x 10⁵	
7.	.9682	.41		8.2 x 10³	1.0100	.25	1.52	> 1 x 10⁵	
8.	.9515	.43		4.5 x 10³	.9987	.15	1.95	> 1 x 10⁵	
9.	.9650	.49		5.0 x 10³	1.0015	.23	2.79	> 1 x 10⁵	
10.	.9677	.38		8.5 x 10³	1.0122	.20	1.84	> 1 x 10⁵	
11.	.9881	.36		4.0 x 10³	1.0038	.27	3.62	> 1 x 10⁵	
12.	.9849	.37		850	1.0015	.29	2.95	> 1 x 10⁵	
13.	1.0150	.53		12.5 x 10³	1.0310	.14	.96	> 1 x 10⁵	
14.	.9870	.40		8 x 10³	1.0127	.22	2.79	> 1 x 10⁵	
15.	.9782	.22		2 x 10³	.9996	.30	3.09	> 1 x 10⁵	
16.	.9712	.40		7.2 x 10³	.9710	.13	4.73	> 1 x 10⁵	
17.	.9765	.35		25 x 10³	1.0236	.18	1.82	> 1 x 10⁵	
18.	.9855	.44		70 x 10³	.9849	.21	5.06	> 1 x 10⁵	
19.	.9550	.42		18 x 10³	.9821	.17	5.68	> 1 x 10⁵	
20.	.9388	.15		2.7 x 10³	1.0327	.26	1.27	> 1 x 10⁵	
21.	.9930	.40		4.1 x 10³	1.0278	.20	1.06	> 1 x 10⁵	
22.	.9523	.22		2.5 x 10³	.9880	.27	4.80	> 1 x 10⁵	
23.	.9570	.37		2.0 x 10³	.9865	.12	5.57	> 1 x 10⁵	
24.	.9570	.50		2.5 x 10³	1.0120	.17	3.02	> 1 x 10⁵	

1 No requirement. Data for information purposes only.

The above tests indicate that the capacitors meet the specification requirements in all respects.

DEA-74

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-21R.000 Date 13 February 1962
Test Data Exhibit WCLK 58-1 Page 1 of 1
Dearborn Type No. MTF205-J2 Capacity 2.0 MFD Voltage 200 VDC Tolerance ± 5%
Life Test Voltage 140 % Temperature 200 °C Hours 1000

	BEFORE LIFE TEST				AFTER LIFE TEST				BEFORE LIFE TEST at 200 °C		
	60 cyles		IR MEGOHMS +25 °C	IR MEGOHMS °C	——— cycles			IR MEGOHMS			IR MEGOHMS
	CAP. MFD	D.F %			CAP. MFD	D.F %	CAP CHG.		CAP. MFD	D.F %	
REQD	2.0 ± 5%	≤ .5	≥ 2500						NR[1]	NR[1]	≥ 500
1	2.06	<.01	100 X 10^5						2.04	<.1	2000
2	2.00	<.01	>100 X 10^5						1.98	<.1	5000
3	2.04	<.01	7.4 X 10^3						2.01	<.1	1300
4	1.99	<.01	100 X 10^5						1.98	<.1	550
5	2.02	<.01	45 X 10^5						2.00	<.1	200
6	2.02	<.01	100 X 10^5						2.00	<.1	8000
7	1.99	<.01	1.4 X 10^3						1.97	<.1	2000
8	2.00	<.01	80 X 10^5						1.98	<.1	1100
9	2.04	<.01	8.2 X 10^5						2.01	<.1	9000
10	1.99	<.01	4.5 X 10^5						1.95	<.1	1100
11	2.01	<.01	3.4 X 10^3						1.99	<.1	3000
12	1.98	<.01	33 X 10^5						1.95	<.1	700

1 No requirement. Data for information purposes only.

EXHIBIT 13

DEA-74

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462-43R-000
Date 4-2-62
Test Data Exhibit WC4K58-1
Page 1 of 1
Dearborn Type No MTF20532 Capacity 2.0 uF Voltage 200 VDC Tolerance ±5%
Life Test Voltage 140 % Temperature 200 °C Hours 1000

	AFTER LIFE TEST +200°C				AFTER LIFE TEST +25°C				
	60 cycles		IR MEGOHMS	IR MEGOHMS	60 cycles			IR	
	CAP MFD	DF %	+25°C	200°C	CAP MFD	D.F.%	CAP CHG	MEGOHMS	REMARKS
	NR[1]	NR[1]		≥ 500	2.0	2.5	≤10%	≥ 2500	
1.	OPEN*								
2.	1.98	.10		4500	2.02	.06	.99	>1x10^5	
3.	OPEN*								
4.	1.95	.10		600	1.98	.03	.50	>1x10^5	
5.	1.99	.25		2000	2.02	2.00*	0	>1x10^5	
6.	1.98	.11		6800	1.99	.04	1.49	>1x10^5	
7	1.95	.10		1800	1.97	.02	1.01	>1x10^5	
8.	1.98	.10		1000	1.99	.06	.50	>1x10^5	
9.	OPEN*								
10.	1.93	.11		1000	1.95	.01	2.01	>1x10^5	
11	1.97	.13		2700	2.00	.02	.50	>1x10^5	
12	1.93	2.00		750	1.95	1.50*	1.52	>1x10^5	

[1] No requirement. Data for information purposes only.

* The above tests indicate that two of the units exceed the dissipation factor requirement of .5% and three were open after life test.

High energy produced by numerous momentary breakdowns weakened or destroyed the connection between the sprayed end connections and the electrodes.

DEARBORN ELECTRONIC LABORATORIES, INC.
Orlando, Florida

Report No. 462.21R-000 Date 13 February 1962

Test Data Exhibit WCLK 58-1 Page 1 of 1

Dearborn Type No. MTE405J/ Capacity 4.0 MFD Voltage 100 VDC Tolerance ± 5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	BEFORE LIFE TEST				AFTER LIFE TEST.				BEFORE LIFE TEST AT 200°C		
	60 cycles CAP. MFD	DF %	IR MEGOHMS +25 °C	IR MEGOHMS	___ cycles CAP. MFD.	DF %	CAP. CHG.	IR MEGOHMS	CAP. MFD	DF %	IR MEGOHMS
REQD	4.0 ± 5%	≤ .5	≥ 1250						NR[1]	NR[1]	≥ 500
1	4.00	.01	50×10^4						3.99	<.1	1500
2	3.92	.01	5.5×10^4						3.90	<.1	750
3	4.01	.02	6×10^4						3.98	<.1	900
4	4.04	.01	8.5×10^4						4.03	<.1	1000
5	3.95	.01	7.5×10^4						3.89	<.1	1200
6	3.86	.01	16×10^4						3.86	<.1	1100
7	4.08	.01	10×10^4						4.05	<.1	750
8	3.88	.02	20×10^4						3.83	<.1	1100
9	3.99	.01	1.5×10^4						3.96	<.1	900
10	3.94	.01	100×10^4						3.90	<.1	1250
11	3.96	.01	12×10^4						3.92	<.1	1200
12	3.91	.01	10×10^4						3.90	<.1	1100

1 No requirement. Data for information purposes only.

DEARBORN ELECTRONIC LABORATORIES, INC.

Orlando, Florida

Report No. 462-42R-000

Date 4-2-62

Test Data Exhibit NGLK58-1

Page 1 1

Dearborn Type No. MTF405T1 Capacity 4.0 uF Voltage 100 VDC Tolerance ±5%

Life Test Voltage 140 % Temperature 200 °C Hours 1000

	AFTER LIFE TEST + 200°C				AFTER LIFE TEST +25°C				
	60 cycles		IR MEGOHMS	IR MEGOHMS	60 cycles			IR MEGOHMS	REMARKS
	CAP. MFD	DF %	+25°C	+200°C	CAP. MFD	DF %	CAP. CHG		
REQ.	NR[1]	NR[1]		≥ 500	4.0 ±5%	≤ .5	≤10%	≥ 1250	
1.	3.97	2.50		1300	3.99	2.03*	.25	>1x10^5	
2.	3.90	.10		1000	3.94	.08	.51	>1x10^5	
3.	OPEN*								
4.	4.00	2.00		750	4.02	1.50*	.50	>1x10^5	
5	3.90	.12		950	3.94	.03	.25	>1x10^5	
6.	3.85	.10		1100	3.91	.02	1.30	>1x10^5	
7.	4.05			950	4.06	1.95*	.49	>1x10^5	
8.	3.85	.10		700	3.87	.04	.26	>1x10^5	
9.	OPEN *								
10	OPEN *								
11	3.91	.13		1300	3.93	.03	.76	>1x10^5	
12	3.88	.10		1000	3.91	.01	0	>1x10^5	

[1] No requirement. Information for data purposes only.

* The above tests indicate that three (3) of the units exceeded the dissipation factor requirement of .5% and three (3) were open after life test.

High energy produced by numerous momentary breakdowns weakened or destroyed the connection between the sprayed end connections and the electrodes.

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